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Honeycomb form electret filter having good dust-collecting properties

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Electret non-woven fabric laminated sheet is moulded to honeycomb form electret filter. The laminated sheet has following (A) and (B).
(A) Electret non-woven fabric which consists of film-unbinding yarn.
(B) Electret non-woven fabric which consists of melt blown method non-woven fabric.

USE/ADVANTAGE - The filter is used for an air cleaner, an air conditioner, a vacuum cleaner, an air filter of a motorcar etc. The filter has good dust-collecting property. It has low pressure loss and long life of collecting property.

In an example, electret non-woven fabric was prep'd. from 97 pts. wt. polypropylene and 3 pts. wt. polypropylene denatured by maleic anhydride and (A) and (B) were laminated by heat embossing welding.

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(54) [TITLE OF THE INVENTION]

HONEY COMB SHAPED ELECTRET FILTER, AND MANUFACTURING METHOD OF THE
SAME

[Honey comb jo electret filter oyobi sono seizohoho]

(57) [ABSTRACT]

[PURPOSE]

To offer a honey comb shaped electret filter showing excellent dust collecting property and low pressure loss, and excellent retention of collecting and capturing performance, and manufacturing method of the same.

[CONSTITUTION]

A honey comb shaped electret filter comprising an electret converted nonwoven cloth laminate sheet that is molded in a honey comb shape, and said nonwoven cloth laminate sheet of said honey comb shape electret filter being a laminate sheet having (A) electret converted nonwoven cloth layer comprising film split yarn and (B) electret converted nonwoven cloth comprising nonwoven cloth by a melt blown method, and manufacturing method of the same.

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[note: All names, addresses, company names, and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified with numeral prefix or general form of plurality suffix. Translator's note]

[CLAIMS]

[CLAIM ITEM 1]

A honey comb shaped electret filter that is prepared by molding a nonwoven cloth laminate that is converted to electret in a honey comb shape, wherein said nonwoven cloth laminate sheet being a laminate sheet having (A) electret converted nonwoven cloth comprising film split fiber yarn, and (B) electret converted nonwoven cloth comprising nonwoven cloth by a melt blown method.

[CLAIM ITEM 2]

Manufacturing method of honey comb shaped electret filter includes such processes as; a process that forms an electret converted nonwoven cloth (A) by splitting said electret converted film after forming an electret converted film by converting a thermoplastic resin film as electret; and a process that forms an electret converted nonwoven cloth (B) by converting a nonwoven cloth of melt blown method comprising thermoplastic resin as electret; and a process to form a nonwoven cloth laminate sheet by laminating said electret converted nonwoven cloth (A) and electret converted nonwoven cloth (B); and a process to mold said nonwoven cloth laminate sheet in a honey comb shape.

[CLAIM ITEM 3]

The manufacturing method of honey comb shaped electret filter according to the claim item 2, wherein said lamination is conducted through a heat embossing melt adhesion method.

[CLAIM ITEM 4]

The manufacturing method of honey comb shaped electret filter according to the claim item 2, wherein said lamination is conducted through an ultrasonic wave melt adhesion method.

[CLAIM ITEM 5]

The manufacturing method of honey comb shaped electret filter according to the claim item 2, wherein said lamination is conducted through a needle punch method.

[DETAILED EXPLANATION OF THE INVENTION]

[0001]

[FIELDS OF INDUSTRIAL APPLICATION]

This invention relates to a honey comb shaped electret filter and manufacturing method of the same; and in particular, it relates to the honey comb shaped electret filter that shows excellent dust collecting property, low pressure loss, and excellent retention of collecting and capturing performance, and manufacturing method of the same.

[0002]

[PRIOR ART]

The method of manufacturing electret converted nonwoven cloth by molding polyolefin, for instance, polypropylene as a nonwoven cloth by a melt blow method and applying direct current high voltage to thus given nonwoven cloth to convert this to electret is disclosed in the Japanese Patent Applications Kokai Sho 60[1985]-168511 and Kokai Hei 2[1990]-197110 publications.

[0003]

This electret converted nonwoven cloth is known for its application as a filter by, for instance, forming this in a pleated shape and passing a gas flow inside of this to adsorb and remove fine particles such as dust, or dirt within said gas flow by an electrostatic force.

[0004]

However, the filter that uses electret converted nonwoven cloth is known for the problems of (1) high pressure loss, and (2) short life due to clogged particles.

[0005]

A filter that molds said electret converted nonwoven cloth into a honey comb shape has been proposed in order to solve thus problems (make reference to the Japanese Patent Application Kokoku [post-examined] Sho 59[1984]-51323 and the like).

[0006]

[SUBJECTS SOLVED BY THIS INVENTION]

However, as a result of studies conducted by these inventors, it became clear that even in the case of this type of honey comb shaped electret converted filter, it does not necessarily satisfy any of the three points including (a) low pressure loss, (2) high collecting and capturing performance, and (3) long life. For instance, in the case of a filter for air conditioning purpose, requirements include at most mmAq [level of] pressure loss, at least 12% collecting and capturing performance, and life that shows collecting and capturing performance of tobacco particles over at least 100 [cigarettes].

[0007]

And therefore, the purpose of this invention is to offer a honey comb shaped electret filter for air conditioning purpose that shows low pressure loss and excellent collecting and capturing performance as well as life of collecting and capturing performance over long period of time, and method of manufacturing such honey comb shaped electret filter.

[0008]

[MEASURES USED TO SOLVE THE SUBJECTS]

This invention solves said subjects with a honey comb shaped electret filter formed by shaping an electret converted nonwoven cloth laminate sheet in a honey comb shape, and offers honey comb shaped electret filter of which said nonwoven cloth laminate sheet being a laminate sheet having (A) electret converted nonwoven cloth comprising film split fiber yarn, and (B) electret converted nonwoven cloth comprising a nonwoven cloth of a melt blown method.

[0009]

In addition, this invention also offers manufacturing method of honey comb shaped electret filter that includes following processes as a method of manufacturing said honey comb shaped electret filter: a process to first form an electret converted film by converting a thermoplastic resin film as electret, and then, to form an electret converted nonwoven cloth (A) by splitting fiber yarn of said electret converted film ; and a process to form n electret converted nonwoven cloth (B) by converting a nonwoven cloth by a melt blown method comprising a thermoplastic resin as electret; and a process to laminate said electret converted nonwoven cloth (A) and electret converted nonwoven cloth (B) to form a laminate sheet; and a process to mold said laminate sheet in a honey comb shape.

[0010]

This invention's honey comb shaped electret filter (this will be hereafter referred to as "this invention's filter") and its manufacturing method are further explained below in details.

[0011]

This invention's filter is formed by shaping a laminate sheet having (A) electret converted nonwoven cloth comprising film split fiber yarn and (B) electret converted [note: original document does not state the subject in this tense. Translator's note] comprising a nonwoven cloth of a melt blown method in a honey comb shape. These nonwoven cloth (A) and (B) are formed of a thermoplastic resin. The thermoplastic resin that may be used is not particularly limited, and it is possible to use various types of thermoplastic resins. In particular, use of polyolefin group polymers having polar groups or polyolefin composition that includes said polyolefin group polymers is recommended from the standpoint of easy electret conversion and excellent retention of charges and collecting and capturing performance. The polyolefin group polymers having polar groups or polyolefin composition include single polymers such as

- (A) copolymers of monomer having polar groups and α -olefin,
- (B) modified polyolefin to which side chain or main chain of polyolefin, polar groups are induced through oxidation or halogenation,
- (C) modified polyolefin prepared by graft copolymerizing polyolefin or said (B) polymer and monomers having polar group,
- (D) mixture of unmodified polyolefin and at the least one type selected from said (A), (B) and (C) ; or composition having mixture of these as the main components. At this time, when polyolefin composition happens to include modified polyolefin and unmodified polyolefin, the modified polyolefin and unmodified polyolefin may be of mutually the same or varied polyolefins.

[0012]

As for the polar groups which are included in said polyolefin group polymers or polyolefin composition that includes said polyolefin group polymers, for instance, halogen atoms such as chlorine atom, fluorine atom, bromine atom, or iodine and the like; atom groups of carbonyl group, or nitro group and the like; or groups shown with formulas below may be mentioned.

-COOCH₃, -COOC₂H₅, -OCOCH₃, -OC₂H₅, -OCH₂C₆H₅, -COOH, -OH, -NH₂, -CONH₂, -COONH₄,

[0013]

[CHEMICAL FORMULA 1]

[0014]

Either one or more than two types of these polar groups may be included in said polyolefin group polymers or polyolefin composition. Said polyolefin group polymers or polyolefin composition that includes said polyolefin group polymer will be hereafter referred to as "polyolefin group composition".

[0015]

In addition, concrete examples of said (A) copolymers of monomers having polar groups and α -olefin includes copolymers of pentabromo phenyl methacrylate that has the group shown with formula (iii), or 2,4,6-trobromo phenyl methacrylate that has group shown with formula (iv), or trifluoro ethyl methacrylate that has group shown with formula (v) and the like, and α -olefin such as ethylene or propylene and the like.

[0016]

Furthermore, concrete examples of (B) modified polyolefin prepared by inducing polar groups to either side chain or main chain of polyolefin through either oxidation or halogenation include the ones which are subjected to such treatments as an oxidation by reacting polyethylene or polypropylene and the like with ozone or nitrogen monoxide and the like, or a surface oxidation by a corona discharge treatment to form carbonyl group or nitro group within molecules; or the ones of which polyolefin is chlorinated to induce chlorine atoms into molecules.

[0017]

In addition, concrete examples of (C) modified polyolefin prepared by graft copolymerization of monomers having polar groups include modified polyolefin that is modified with monomer modifier of at the least one type selected from unsaturated carboxylic acid or its derivatives.

[0018]

Said modified polyolefin or polyolefin having the major component of unmodified polyolefin is single polymer of α -olefin, copolymers comprising more than two types of α -olefin, or mixture of more than two types selected from these. As α -olefin, for instance, ethylene, propylene, 1-butene, 1-pentene, 1-hexene, isopentene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-octene, 1-decene, 1-hexadecene, 1-octadecene, or 1-eicosene and the like may be mentioned.

[0019]

Concrete examples of these polyolefin, polyethylene, polypropylene, poly-1-butene, poly-4-methyl-1-pentene, ethylene, propylene copolymer, ethylene, 1-butene copolymer, ethylene, 4-methyl-1-pentene copolymer, propylene, 1-butene copolymer, or 4-methyl-1-pentene, 1-decene copolymer and the like may be mentioned. Among these examples, use of polypropylene, poly-1-butene, poly-4-methyl-1-pentene, in particular is recommended from the standpoint of high strength, and easy adjustment to appropriate melt viscosity, and easy molding by a melt blow method; and in particular, polypropylene is most recommended from the standpoint of reasonable cost, easy molding, and easy conversion to electret.

[0020]

In addition, as these polyolefin shows appropriate flow characteristics, it provides easy manufacturing to manufacture a nonwoven cloth by a melt blow method; and their $[\eta]$ should be generally within a range of 0.5 ~ 3 dl/g, or more preferably, 0.7 ~ 1.5 dl/g, and most preferably, 0.8 ~ 1.3 dl/g from the standpoint of providing a nonwoven cloth with excellent strength. According to this invention, $[\eta]$ refers to the value that is measured in decalin at 135°C.

[0021]

The (C) modified polyolefin is modified by a graft copolymerization of said polyolefin and at the least one type of monomer modifier selected from unsaturated carboxylic acid and its derivatives. It is preferable to use the polyolefin that is either identical or well miscible polyolefin with unmodified polyolefin as said modified polyolefin. For instance, when using a composition that includes modified polyolefin and unmodified polyolefin as the components of polyolefin group composition, if polypropylene is used as said unmodified polyolefin, it is better to use polypropylene as a raw material of polyolefin of the graft modified polyolefin.

[0022]

As unsaturated carboxylic acid or its derivatives which are used as modifier monomers to graft modify said (C) modified polyolefin, for instance, unsaturated carboxylic acid, its anhydride, ester, amide, imide, or chloride and the like may be mentioned.

[0023]

Concrete examples of said unsaturated carboxylic acid and its derivatives include acrylic acid, methacrylic acid, vinyl acetate, ethyl acryl acetate, 2,4-pentadienoic acid, carboxy styrene, maleic acid, fumaric acid, itaconic acid, citraconic acid, allyl succinic acid, mesaconic acid, glutaconic acid, Nadic acid, methyl Nadic acid, tetrahydrophthalic acid, methyl acrylate, ethyl acrylate, butyl acrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate, monomethyl maleate, dimethyl maleate, monoethyl maleate, diethyl maleate, monomethyl fumarate, dimethyl fumarate, monoethyl fumarate, diethyl fumarate, monomethyl citraconate, dimethyl citraconate, monoethyl citraconate, diethyl citraconate, monomethyl Nadate, dimethyl Nadate, monoethyl Nadate, diethyl Nadate, glycidyl acrylate, glycidyl methacrylate, maleic acid anhydride, itaconic acid anhydride, citraconic acid anhydride, methyl hexahydrophthalic acid, 3,6-endo methylene phthalic acid anhydride, methyl tetrahydrophthalic acid anhydride, acryl amide, methacryl amide, monoamide maleate, diamide maleate, maleic acid-N-monoethyl amide, maleic acid-N,N-diethyl amide, maleic acid-N-monobutyl amide, maleic acid-N,N-diethyl amide, monoamide fumarate, diamide fumarate, fumaric acid-N-monoethyl amide, fumaric acid-N,N-diethyl amide, fumaric acid-N-monobutyl amide, fumaric acid-N,N-dibutyl amide, maleimide, N-butyl maleimide, N-phenyl maleimide, sodium acrylate, sodium methacrylate, potassium acrylate, or potassium methacrylate and the like. These may be used either alone or as mixture of more than two types. Use of maleic acid anhydride is recommended among these.

[0024]

As for the method of adjusting (C) modified polyolefin through a graft copolymerization of above-explained modifier monomer with polyolefin, already known various methods may be used. For instance, it may be conducted by a method that heats and react polyolefin and modifier monomer with or without addition of radical polymerization initiator in presence or absence of solvent to high temperature. In addition, during such reaction, it is all right when other vinyl monomers such as styrene and the like are in coexistence.

[0025]

Content of modifier monomer in the (C) modified polyolefin, in other words, grafting ratio of (C) modified polyolefin generally adjusted to at most 3 mole %, or more preferably, it is recommended to adjust to at most 1.5 mole %. In particular, when forming nonwoven cloth (A) and/or nonwoven cloth (B) by using modified polyolefin along as polyolefin group composition, it is recommended that the grafting ratio of at most 1 mole %.

[0026]

In addition, intrinsic viscosity (135°C decalin) of said (C) modified polyolefin should be generally 0.1 ~ 3.0 dl/g, or more preferably, 0.3 ~ 2.0 dl/g, and most preferably, 0.5 ~ 1.5 dl/g from the standpoint of easy uniform mixing with unmodified polyolefin and appropriate flow characteristics, and easy manufacturing of nonwoven cloth of a melt blown method.

[0027]

According to this invention, when polyolefin group composition that includes unmodified polyolefin and modified polyolefin is used as the main material for said nonwoven cloth (A) and nonwoven cloth (B), content ratio of modified polyolefin/unmodified polyolefin in said polyolefin group composition based on by weight is generally about 0.1/99.9 ~ 20/80, or more preferably, about 1/99 ~ 5/95.

[0028]

In addition, it is all right to compound various additives in polyolefin group composition other than said modified polyolefin and unmodified polyolefin at such range so not to ill affect the purpose of this invention. As said additives, for instance, antioxidants, UV ray absorbents, pigment, dye, nucleating agents, fillers, slip agents, antiblocking agents, lubricant, flame retardant, or plasticizers and the like may be mentioned.

[0029]

Furthermore, adjustment of polyolefin group composition may be conducted in accordance with various ordinary methods. For instance, this may be conducted in accordance with a method that first mix said modified polyolefin and/or unmodified polyolefin, and various additives as needed, and then subject this to a fusion kneading. As kneader which may be used, for instance, ribbon blender, V-type blender, tumbler, Henschel mixer and the like may be mentioned. In addition, fusion kneading may be conducted by using, for instance, single or biaxial extruder, Banbury mixer, kneader, or dual roll and the like.

[0030]

The laminate sheet that constitutes this invention's filter has a (A) nonwoven cloth formed of thermoplastic resin of which representative example if said polyolefin group composition, and (B) nonwoven cloth, and nonwoven cloth (A) comprises film split yarn, and nonwoven cloth (B) comprises nonwoven cloth of a melt blown method; and the nonwoven cloth that constitutes both layers are converted to electret. The nonwoven cloth (A) and nonwoven cloth (B) may be formed of a thermoplastic resin of identical components or thermoplastic resin of varied components.

[0031]

According to said nonwoven cloth (A), it is formed of film split yarn, and its manufacturing method is not particularly limited as long as it is manufactured by splitting of a thermoplastic resin film. For instance, thermoplastic resin of which representative example is said polyolefin group composition is fused in an extruder, and is extruded from an annular die to form a film. This film is then, cut to a set width by a slitter, or said film is drawn at higher rate than its elongation ratio to split this to manufacture said split yarn. Then, thus split yarn is uniformly dispersed in the width direction of the sheet by using a device such as, for instance, a carding and the like, and then, it is preferably press adhered with an emboss roll and the like to manufacture this.

[0032]

This nonwoven cloth (A) is the electret converted nonwoven cloth showing 20 ~ 60 μm average fiber diameter of single fiber, and 10 ~ 30 g/m^2 Metsuke [basis weight], 0.05 ~ 0.2 g/cm^3 bulk density, and at least 0.1×10^{-9} Coulomb / cm^2 average surface charge density. At this time, average fiber diameter of single fiber is the value that is sought by photographing a surface of fibre specimen with an electron microscope (500 x magnification) and selecting 30 fibre optionally on thus given photograph to measure fiber diameter of each fiber through use of caliper and the like, and calculating the average value of thus measured values of each fiber diameter.

[0033]

In addition, electret conversion treatment of the nonwoven cloth (A) may be conducted either during film molding, or nonwoven cloth may be converted to electret after molding of said nonwoven cloth. When this is conducted during film molding, as electret conversion efficiency is excellent, it provides better collecting and capturing performance compared to those by electret conversion of nonwoven cloth after molding, and is desirable.

[0034]

Electret conversion may be conducted by applying direct current voltage to a nonwoven cloth or a film. Direct current voltage value that is applied may be selected appropriately in accordance with shape of electrodes used, distance between electrodes and the like, and charge rate required for the electret converted nonwoven cloth, and treatment speed and the like. For instance, when distance between electrodes is 8 mm, it may be conducted by applying at the least -5 kV, or more preferably, -6 ~ -20 kV direct current voltage to the nonwoven cloth.

[0035]

Application of direct current voltage may be conducted by any methods with no particular limitation. For instance, a method of application by passing nonwoven cloth or film between one pair of electrodes to which direct current voltage is applied; or a method to apply corona discharge or pulse-form high voltage on the surface of nonwoven cloth; or a method to hold front and back planes of nonwoven cloth with other dielectric to apply direct current high voltage to both planes may be used.

[0036]

Furthermore, the nonwoven cloth by melt blown method that constitute said nonwoven cloth (B) is prepared by first supplying a thermoplastic resin, or more preferably, said polyolefin group composition, to an extruder to heat, fuse, and knead, and by extruding as fine resin flow from a die for melt blow purpose having multiple numbers of fine pores. Thus extruded resin flow is contacted with a high speed hot gas flow to quench and solidify to form discontinuous fibre with fine fiber diameter, and said fibre is accumulated on a porous support body.

[0037]

Heating temperature for fusion and kneading of the polyolefin group composition may be appropriately adjusted in accordance with the melt point of polyolefin that is the major component of polyolefin group composition. It is recommended to generally set to about 200 ~ 350°C, or in particular, within a range of 220 ~ 300°C from the standpoint of not causing lower molecular weight through Gensei [transliteration, may be a misprint of decay meaning Gensui, translator's note] of the polyolefin , provision of nonwoven cloth showing good mechanical strength, and appropriate fusion viscosity of the fused polyolefin group composition to allow an easy fusion molding.

[0038]

Fusion kneading and extrusion discharge rate of polyolefin group composition is generally about 10 ~ 130 kg/hr.

[0039]

In addition, the die for melt blow purpose that is used has multiple numbers of fine pores to discharge fused polyolefin group composition at its top end of lip part; and generally it shows width of 1000 ~ 2000

mm. These pores are arranged at top end of lip part in the numbers of generally 800 ~ 3000 pieces; and pore diameter is generally about 0.5 mm.

[0040]

Furthermore, said fused polyolefin group composition is contacted with a high speed and heated gas in a melt blow die, and this is made to split while it is drafted in a fused state and is drawn in the direction of fiber length, and at the same time, narrowing of fiber diameter progresses. And to do so, the melt blow die is equipped with a device that allows an introduction of high speed and heated gas flow, and contacts said fused polyolefin group composition with this heated gas flow at either inside or outside of the die to mold a discontinuous form single fiber. This device may be arranged in such manner that an outlet for heated gas flow is arranged inside of the melt blow die, or an outlet of heated gas flow may be arranged at outside of top end lip of the melt blow die to allow said heated gas flow to blow against the fused polyolefin composition.

[0041]

Heated gas is not particularly limited; and heated air is generally used from the standpoint of cost; and it is all right to use heated inert gas for purpose of preventing degradation of polyolefin group composition. Temperature of heated gas flow is generally 200 ~ 360°C, or more preferably, 230 ~ 310°C; and it is desirable that the temperature is at the least higher by about 10°C than the temperature of fused polyolefin composition. In addition, flow speed of the heated gas flow is generally 100 ~ 600 m/sec, or more preferably, about 200 ~ 400 m/sec.

[0042]

Fine discontinuous form of single fiber discharged from the die for melt plow may be accumulated on a porous support body to obtain a web-form nonwoven cloth of melt blown method. As this porous support body, for instance, mesh structure and the like made of stainless steel, or polyester and the like may be used.

[0043]

According to this nonwoven cloth (B), average fiber of single fiber [note: original document does not state average fiber diameter, may be an omission, translator's note] is generally about 0.5 ~ 10 μ m, or more preferably, within a range of 1 ~ 6 μ m, and fiber length is generally about 50 ~ 400 mm. In addition, bulk density is about 0.05 ~ 0.40 g/cm³, and Metsuke [basis weight] is generally about 5 ~ 100 g/m² or more preferably within a range of 10 ~ 80 g/m² from the standpoint of providing a nonwoven cloth with appropriate aeration and high strength, and less uneven Metsuke [basis weight] at local regions.

[0044]

Furthermore, although thickness of nonwoven cloth (B) is determined in accordance with Metsuke [basis weight] and bulk density, it is generally about 0.1/0.7 mm.

[0045]

Electret conversion of this nonwoven cloth (B) may be conducted in the same manner as explained in the electret conversion of said nonwoven cloth (A).

[0046]

Furthermore, as for the average surface charge density of the nonwoven cloth (B), it is generally at least 0.1 \times 10⁻⁹ Coulomb/cm², or more preferably, 0.3 ~ 5 \times 10⁻⁹ Coulomb/cm².

[0047]

In addition, as for the limit viscosity $[\eta]$ (135°C, decalin) of thermoplastic resin that forms said single fibre which are the constituting material of the electret converted nonwoven cloth (B), it is 0.3 ~ 1.5 dl/g, or more preferably, 0.5 ~ 1.0 dl/g.

[0048]

The laminate sheet that constitutes this invention's filter has said nonwoven cloth (A) and nonwoven cloth (B). The layer constitution of the laminate sheet may be not only nonwoven cloth (A)/nonwoven cloth (B), but also nonwoven cloth (B)/nonwoven cloth (A)/nonwoven cloth (B), and nonwoven cloth (A)/nonwoven cloth (B)/nonwoven cloth (A); and laminate structure that provides nonwoven cloth (A)/nonwoven cloth (B) is best recommended from the standpoint of attaining this invention's purpose.

[0049]

In addition, preferred thickness of the nonwoven cloth (A) in the laminate sheet is 0.1 ~ 0.5 mm, and preferred thickness of nonwoven cloth (B) is 0.1 ~ 0.7 mm; and preferred thickness of entire laminate nonwoven cloth sheet is 0.2 ~ 1 mm.

[0050]

As for the manufacturing of laminate sheet, it can use a method that forms said nonwoven cloth (A) and nonwoven cloth (B) in each roll form, and then, feeding each nonwoven cloth from said rolls at the same speed to supply to a lamination and integration device to laminate these, and thus given laminate sheet is taken up. In addition, a method that introduces nonwoven cloth (B) to a molding device at the same time of molding said nonwoven cloth (A) to laminate both may be also used.

[0051]

As for the device that is used to laminate and integrate two nonwoven cloth, for instance, hot roll or ultrasonic wave melt adhesion and the like may be mentioned. According to the hot roll method, it is recommended to conduct a lamination treatment on both nonwoven cloth sheets with emboss roll heated to 110°C ~ 140°C. In addition, in the case of ultrasonic wave melt adhesion, it is recommended to conduct lamination under such conditions as 10 ~ 50 kHz frequency and 2~ 4 kg/cm² hone pressure. Among these lamination methods, heat embossing melt adhesion method with less charge loss is better recommended from the standpoint of possible attainment of laminate sheet showing high rigidity of molded body and good honey comb shaping property.

[0052]

This invention's filter is formed by molding said laminate sheet in a honey comb shape. As for the method of molding this laminate sheet in a honey comb sheet, it is not particularly limited; and for instance, it is all right to use a method to first slit said laminate sheet to set width, and folds or bends continuously to form pleats over entire plane of the nonwoven sheet to provide thickness while forming a structure showing multiple continuous voids, in other words, honey comb shaped cells. Mutual contact adhesion of laminate sheet is recommended in a form of mutual anchoring through adhesive agent or melt adhesion of the laminate sheets mutually.

[0053]

According to the manufacturing method of this honey comb shaped cells, as illustrated in the Figure 1 (a), it may be conducted with such method that first continuously folds a laminate sheet (1) having nonwoven cloth (A) and nonwoven cloth (B) to prepare the first sheet (4) having continuous multiple numbers of hills (2) and valleys (3). This first sheet (4) is piled on a flat second sheet (5) comprising

nonwoven cloth (A) and nonwoven cloth (B) to adhere bottom portion (6) of the valleys (3) with the surface of second sheet (6) to prepare a constitution unit (7) as illustrated in the Figure 1 (b). Then, after preparing prescribed numbers of constitutional units (7), as illustrated in the Figure 1 (c) first constitutional unit (7₁) and second constitutional unit (7₂) are laminated, and top part (8) of the hill (2) of the first constitutional unit (7₁) is adhered to the bottom surface of second constitutional unit (7₂), and furthermore, third constitutional unit (7₃) is laminated on the second constitutional unit (7₂) in the same manner, and top part of the hill of second constitutional unit (7₂) is adhered to the bottom surface of the third constitutional unit (7₃). This lamination and adhesion processes are repeated, or combination of one pair of laminate of first sheet (4) and second sheet is formed in multiple numbers, and said combination pair is piled in prescribed number of sheets to form a structure having multiple numbers of honey comb shaped cells (9).

[0054]

According to this invention's filter, thickness of the honey comb is 5 ~ 20 mm, and shape of unit cell of honey comb is as illustrated in the Figure 1; and in general, the cell height is 1 ~ 5 mm, and bottom side of the cell is 2 ~ 10 mm,

[0055]

[EXAMPLES]

Examples are described to provide further specific explanation of this invention; however, this invention should not be limited to these examples providing gist of this invention is not superseded.

[0056]

(EXAMPLE 1)

Polyolefin composition (composition 1) was adjusted by mixing 97 parts by weight polypropylene (A) showing 0.91 g/cm³ density and 800 g/10 minutes MFR (ASTM D 1238), and 3 parts by weight maleic acid anhydride modified polypropylene (B) (graft rate of maleic acid anhydride : 2.7 weight %, intrinsic viscosity: 0.3 dl/g) in a tumbler blender. Content of maleic acid anhydride in this composition 1 was 3.9 x 10⁻² mole %.

[0057]

Then, this composition 1 was thrown into a uniaxial extruder with 65 mm ϕ screw diameter; and this was fused at 310°C, and it was discharged at 20 kg/hr discharge rate from a die for melt blow purpose that is connected to a top end of the extruder, and at the same time, it was taken up at 13m/min take up speed to form a nonwoven cloth of melt blown method. The die for melt blow that was used has opening of two rows of molding pores (pore diameter : 0.5 mm ϕ , pore distance: 0.8 mm) which are arranged over an entire width of the die (die width : 1.3 m). In addition, during this molding, 320°C heated air was injected to the die for melt blow at 500 m³/hr flow rate.

[0058]

Thus given nonwoven cloth of melt blown method showed 0.49 mm thickness, 30g/m² Metsuke [basis weight], and 0.067 g/cm³ bulk density. In addition, when fibre which constitute nonwoven cloth of melt blown method were observed through a microscope to measure average fiber diameter, it was 4 μm . In addition, the $[\eta]$ of resin which forms the fibre was 0.58 dl/g.

[0059]

Then, this nonwoven cloth of melt blown method was continuously passed through electrode application device having 2 rows of needle-form electrodes arranged at 5 mm distance in lengthwise direction while applying direct current voltage of -18 kV at 20 m/min speed to manufacture an electret converted nonwoven cloth of melt blown method.

[0060]

When average surface charge density of thus given electret converted nonwoven cloth of melt blown method was measured, it was 1.2×10^{-9} Coulomb/cm². Furthermore, measurement of this average surface charge density was conducted by using a surface charge density measuring device made by Rikagaku Kenkyusho to contact electrode probe with 1 cm² area with the surface of said nonwoven cloth.

[0061]

A resin composition was adjusted by mixing 9000g of polypropylene (made by Mitsui Petrochemical Industry Kabushiki Kaisha, Hipole B200 [transliteration] MFR: 0.5g/10 minutes), 500 g of polycarbonate (made by General Electric Co., Lexane 101 [transliteration]), and 500 g of maleic acid anhydride modified polypropylene (modification rate of maleic acid anhydride graft : 3 weight %).

[0062]

Thus given resin composition was fed to an inflation film molding machine (made by Toshiba Kikai Kabushiki Kaisha), and this was molded at 240° C to give a film with 30 μm thickness. Then, this film was drawn by 6.6 x draw magnification rate in longitudinal direction with a hot plate heated to 135°C to give a drawn film. Then, thus drawn film was supplied to corona discharge electrodes to apply a charge treatment at -9 kV applied voltage (direct current), gap of electrodes: 8 mm, residence time 0.5 second; and then, this was placed on pin cushion-like roll to split in a net form, and thus given electret converted split yarn was taken out on a paper tube. This electret converted split yarn was cut to 90 mm with a cutter, and this was opened by an opening machine to give electret converted raw cotton.

[0063]

Then, this electret converted raw cotton was fed to a web forming machine to be molded as a web.

[0064]

This web and said electret converted nonwoven cloth of melt blown method were supplied to a heat emboss roll set at 130°C to paste together through bonding to give a laminate sheet of electret converted nonwoven cloth showing Metsuke [basis weight] : 25 g/m², and thickness of 0.32 mm.

[0065]

Then, this laminate sheet was manufactured as a honey comb shaped electret filter comprising 30 states of honey comb shaped sheets having 70 honey comb cells with 4.2 mm bottom side and 2.7 mm height by the processes illustrated in Figures 1 (a) through (c).

[0066]

Collecting and capturing efficiency of this filter for testing purpose was measured by the method explained below. Results of measurement are shown with average value of 5 measured values at each time. Results are shown in the Table 1.

[0067]

MEASUREMENT OF COLLECTING AND CAPTURING EFFICIENCY

Collecting and capturing efficiency was measured by using a device of which schematic drawing is illustrated in the Figure 2. First of all, NaCl particles (particle diameter : 0.3 μm) was supplied from an aerosol generator (made by Nihon Kagaku Kogyo Kabushiki Kaisha) (11) to a chamber (13) to which clean air was introduced through an air filter (12). After concentration of NaCl reaches set level ($2 \sim 6 \times 10^6$ pieces/cm³) within said chamber, a suction device (14) was used to suction in arrow marking A direction through filter specimen (15) that was arranged at the bottom part of the chamber (13), and NaCl particle density C_{in} and C_{out} at top flow (16) and down flow (17) side were each measured by particle counters (made by Rion K.K., KC-01B) (18a), (18b) when passing wind velocity of the filter reached set

speed ($v = 10$ cm/sec) to seek collecting and capturing efficiency by an equation shown below. (19) shows flow speed meter, and (20) shows flow rate regulating valve.

$$\text{Collecting and capturing efficiency } E = (1 - C_{out} / C_{in}) \times 100 [\%]$$

[0068]

MEASUREMENT OF FILTER LIFE

This was conducted at the same time of collecting and capturing efficiency measurement by using a differential pressure gauge (made by Yamatake Honeywell, KD146).

[0069]

MEASUREMENT OF FILTER LIFE

As illustrated in the Figure 3, a device within which acryl resin made box (21) showing 1 m^3 inner capacity, commercially available air conditioner (made by Matsushita Denki K.K., Eoria [transliteration]) (22) and stirring fan (23) are installed was prepared on hand. Then, a filter for testing purpose was set within an air conditioner, and smoke that is generated by burning of cigarettes was injected into the box (21), and then, decay of smoke concentration was measured by using a powder dust gauge (made by Shibata Kagaku K.K., P-5). Life of the filter was identified in such manner by first injecting smoke caused by burning 1 cigarette into the box (21) that is in such state that filter is not set in the air conditioner, and then, by operating said air conditioner (22) to seek half-life when initial concentration reached $\frac{1}{2}$ to regard this value as a blank. Prescribed number of cigarettes are burned to collect and capture the smoke that is generated from these in a filter, and cumulative number of cigarettes burnt when half-life of amount of powder dust within said box reaches $\frac{1}{2}$ of the difference between blank value and initial value is identified as the life of filter.

[0070]

(EXAMPLE 2)

An electret converted nonwoven cloth was manufactured in the same manner as explained in the example 1 by changing the compounding ratio of polypropylene (A)/(maleic acid anhydride graft modified polypropylene (B) to 95/5 from that of the composition 1 explained in the example 1; and a filter was prepared. The content of maleic acid anhydride in the composition that was used to prepare said filter was 6.5×10^{-2} mole %. Thus given filter showed 0.065 g/cm^3 bulk density, $1.4 \times 10^{-9}\text{ Coulomb/cm}^2$ of average surface charge density, 0.57 dl/g of $[\eta]$ of the resin that forms fibre, and $4\mu\text{m}$ of average fiber diameter. In addition, initial performance of the filter and life of tobacco were also measured. Results are shown in the Table 1.

[0071]

(EXAMPLE 3)

A filter was prepared in the same manner as explained in the example 1 by using a laminate nonwoven sheet prepared by lamination of electret converted nonwoven cloth (A) prepared by ultrasonic wave treatment (treatment conditions: hone pressure; 2.6 kg/cm^2 , frequency; 20 kHz , treatment speed; 25 m/min) instead of the filter given by the method explained in the example 1, and electret converted

nonwoven cloth (B) ; and initial performance of such filter and life of tobacco were measured. Results are shown in the Table 1.

[0072]

(COMPARATIVE EXAMPLE 1)

A honey comb shaped electret filter was manufactured in the same manner as explained in the example 1 by using only the electret converted nonwoven cloth formed of split fiber yarn instead of filter used in the example 1. Bulk density of thus given filter was 0.092 g/cm^3 , and Metsuke [basis weight] was $25\text{g}/\text{cm}^2$. In addition, initial performance of the filter and life of tobacco were measured. Results are shown in the Table 1.

[0073]

(COMPARATIVE EXAMPLE 2)

A honey comb shaped electret filter was manufactured in the same manner as explained in the example 1 by using only the electret converted nonwoven cloth (B) given by a melt blown method instead of the electret filter explained in the example 1. Bulk density of thus given filter was 0.067 g/cm^3 , and Metsuke [basis weight] was $25 \text{ g}/\text{cm}^2$, and average surface charge density was $1.3 \times 10^{-9} \text{ Coulomb}/\text{cm}^2$. In addition, initial performance of the filter and life of tobacco were measured. Results are shown in the Table 1.

[0074]

TABLE 1 FILTER PERFORMANCE

	$\Delta P (\text{mmAq})$	E (%)	life (number of cigarettes)
example 1	0.5	13.2	50
2	0.5	14.1	50
3	0.7	12.2	60
comparative example			
1	0.5	14.3	6
2	1.1	8.8	80

[0075]

[EFFECTS OF THIS INVENTION]

This invention's honey comb shaped electret filter comprising at least 2 layers of said nonwoven cloth (A) and nonwoven cloth (B); and it shows lower pressure loss as well as excellent collecting and capturing performance compared to that of conventional honey comb shaped electret filter comprising nonwoven cloth of melt blown method. In addition, it shows long life of excellent collecting and capturing performance is excellent when compared to that of the conventional filter constituted of nonwoven cloth comprising split fiber yarn.

[0076]

And therefore, this invention's honey comb shaped electret filter may be used favorably as air filters for air conditioners, air cleaners, cleaning machine, fan heater, air conditioning machines for general use, and interiors of the automobiles.

[0077]

In addition, as this invention's honey comb shaped electret filter not only shows high collecting and capturing performance of initial time, but also shows lasting collecting and capturing performance to indicate long filter life when it is used as an air filter, it is useful,

[BRIEF EXPLANATION OF THE DRAWINGS]

[FIGURE 1]

It shows an explanatory view of main processes of manufacturing method of this invention's honey comb shaped electret filter.

[FIGURE 2]

It shows a schematic view that explains method of measuring collecting and capturing efficiency conducted in this invention's examples as well as comparative examples.

[FIGURE 3]

It shows a schematic view that explains method of measuring life of the filter conducted in this invention's examples as well as comparative examples.

[DESCRIPTION OF CODES]

1 laminate sheet, 2 hills, 3 valleys, 4 first sheet, 5 second sheet, 6 bottom part of the valley (3), 7 constituting unit, 8 top part of the hill (2), 9 honey comb shaped cell, 11 aerosol generator, 12 air filter, 13 chamber, 14 suction equipment, 15 filter specimen, 16 top flow of filter specimen (15), 17 down flow of filter specimen (15), 18a, 18b particle counter, 19 flow meter, 20 flow-rate regulating valve, 21 box, 22 air conditioner, 23 stirring fan

Figures 1 through 3

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(57) 【要約】

【目的】集塵性に優れ、かつ、圧力損失が低く、捕集性能の持続性に優れたハニカム状エレクトレットフィルターおよびその製造方法の提供。

【構成】エレクトレット化された不織布積層シートをハニカム状に成形してなるハニカム状エレクトレットフィルターであって、前記不織布積層シートが、フィルム解織糸からなるエレクトレット化不織布層（A）と、メルトブローニ法不織布からなるエレクトレット化不織布層（B）とを有する積層シートであるハニカム状エレクトレットフィルターおよびその製造方法。

【特許請求の範囲】

【請求項1】エレクトレット化された不織布積層シートをハニカム状に成形してなるハニカム状エレクトレットフィルターであって、前記不織布積層シートが、フィルム解織糸からなるエレクトレット化不織布（A）と、メルトブローニ法不織布からなるエレクトレット化不織布（B）とを有する積層シートであるハニカム状エレクトレットフィルター。

【請求項2】熱可塑性樹脂フィルムをエレクトレット化してエレクトレット化フィルムを形成した後、該エレクトレット化フィルムを解織してエレクトレット化不織布（A）を形成する工程と、熱可塑性樹脂からなるメルトブローニ法不織布をエレクトレット化してエレクトレット化不織布（B）を形

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(57) [Abstract]

[Objective] It was superior in dust collecting property, at same time, pressure loss was low, was superior in retention of trapping performance, offer of honeycomb electret filter and its manufacturing method.

[Constitution] Being a honeycomb electret filter which nonwoven fabric laminated sheet which electret formation is done forming in honeycomb, It is a laminated sheet which it possesses aforementioned nonwoven fabric laminated sheet, electret-converted nonwoven fabric layer which consists of film split fiber yarn (A), and electret-converted nonwoven fabric layer which consists of melt blowing method nonwoven fabric (B), honeycomb electret filter and its manufacturing method.

[Claim(s)]

[Claim 1] Being a honeycomb electret filter which nonwoven fabric laminated sheet which electret formation is done forming in honeycomb, honeycomb electret filter which is a laminated sheet which it possesses aforementioned nonwoven fabric laminated sheet, electret-converted nonwoven fabric which consists of film split fiber yarn (A), and electret-converted nonwoven fabric which consists of melt blowing method nonwoven fabric (B).

[Claim 2] Manufacturing method of honeycomb electret filter which is included step which electret formation doing thermoplastic resin film, after forming electret formation film, fiber splitting doing said electret formation film, forms electret-converted nonwoven fabric (A), step which electret formation

成する工程と、前記エレクトレット化不織布（A）とエレクトレット化不織布（B）とを積層して不織布積層シートを形成する工程と、該不織布積層シートをハニカム状に成形する工程とを含むハニカム状エレクトレットフィルターの製造方法。

【請求項3】前記積層を熱エンボス融着法で行う請求項2に記載のハニカム状エレクトレットフィルターの製造方法。

【請求項4】前記積層を超音波融着法で行う請求項2に記載のハニカム状エレクトレットフィルターの製造方法。

【請求項5】前記積層をニードルパンチ法で行う請求項2に記載のハニカム状エレクトレットフィルターの製造方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明はハニカム状エレクトレットフィルターおよびその製造方法に関し、特に、集塵性に優れ、かつ、圧力損失が低く、捕集性能の持続性に優れたハニカム状エレクトレットフィルターおよびその製造方法に関する。

【0002】

【従来の技術】ポリオレフィン、例えば、ポリプロピレンを、メルトブロー法によって不織布に成形し、得られた不織布に直流高電圧を印加してエレクトレット化することによりエレクトレット化不織布を製造する方法が、特開昭60-168511号公報、特開平2-197110号公報等に開示されている。

【0003】このエレクトレット化不織布は、例えば、プリーツ状に形成してその内部に気流を通過させて、該気流中のゴミ、塵等の微粒子を静電力により吸着して除去するフィルターとして使用できている。

【0004】しかし、エレクトレット化不織布を用いるフィルターは、(1)圧力損失が高く、また、(2)粒子が詰まり易いことから寿命が短いという問題があった。

doing melt blowing method nonwoven fabric which consists of thermoplastic resin, forms electret-converted nonwoven fabric (B), step which laminate doing aforementioned electret-converted nonwoven fabric (A) and electret-converted nonwoven fabric (B), forms nonwoven fabric laminated sheet, step which said nonwoven fabric laminated sheet forms in honeycomb.

[Claim 3] Manufacturing method of honeycomb electret filter which is stated in Claim 2 which does the aforementioned laminate with thermal embossing melt bonding method.

[Claim 4] Manufacturing method of honeycomb electret filter which is stated in Claim 2 which does the aforementioned laminate with ultrasonic melt bonding method.

[Claim 5] Manufacturing method of honeycomb electret filter which is stated in Claim 2 which does the aforementioned lamination with needle punch method.

【Description of the Invention】

【0001】

[Field of Industrial Application] This invention regards honeycomb electret filter and its manufacturing method. Especially, it was superior in dust collecting property, at same time, pressure loss was low, was superior in retention of trapping performance, it regards honeycomb electret filter and its manufacturing method.

【0002】

[Prior Art] The method which forms in nonwoven fabric polyolefin, for example, polypropylene, with melt blowing method, imprinting doing direct current high voltage in nonwoven fabric which is acquired, produces electret-converted nonwoven fabric by electret formation doing, is disclosed in Japan Unexamined Patent Publication Showa 60-168511 number disclosure, Japan Unexamined Patent Publication Hei 2-197110 number disclosure etc.

[0003] This electret-converted nonwoven fabric, forming in for example, pleat, passing stream in inside, Adsorbing by electrostatic force, as filter which it removes it has been informed rubbish, dust or other fine particle in said stream that you can use.

[0004] But, as for filter which uses electret-converted nonwoven fabric, (1) pressure loss is high, in addition, there was a problem that (2) particle lifetime is short from the plugging easy thing.

【0005】このような問題を解決するために、前記エレクトレット化不織布をハニカム状に成形してなるフィルターが提案されている（特公昭59-51323号等）。

【0006】

【発明が解決しようとする課題】しかし、本発明者らが検討した結果、このようなハニカム状エレクトレット化フィルターにおいても、必ずしも（1）低い圧力損失、（2）高捕集性能、（3）長期寿命の3点のいずれもを満足することはできないことが判明した。例えば、エアコン用フィルターの場合、圧力損失がmmAq以下、捕集性能が12%以上、タバコ粒子に対する捕集性能の寿命が100本以上であることが要求されている。

【0007】そこで、本発明の目的は、このような低い圧力損失を有し、捕集性能および長期にわたる捕集性能の寿命に優れたエアコン用ハニカム状エレクトレットフィルター、およびそのハニカム状エレクトレットフィルターを製造することができる方法を提供することにある。

【0008】

【課題を解決するための手段】前記課題を解決するため、本発明は、エレクトレット化された不織布積層シートをハニカム状に成形してなるハニカム状エレクトレットフィルターであって、前記不織布積層シートが、フィルム解纖糸からなるエレクトレット化不織布（A）と、メルトブローン法不織布からなるエレクトレット化不織布（B）とを有する積層シートであるハニカム状エレクトレットフィルターを提供するものである。

【0009】また、本発明は、前記ハニカム状エレクトレットフィルターを製造するための方法として、熱可塑性樹脂フィルムをエレクトレット化してエレクトレット化フィルムを形成した後、該エレクトレット化フィルムを解纖してエレクトレット化不織布（A）を形成する工程と、熱可塑性樹脂からなるメルトブローン法不織布をエレクトレット化してエレクトレット化不織布（B）を形成する工程と、前記エレクトレット化不織布（A）とエレクトレット化不織布（B）とを積層して積層シートを形成する工程と、該積層シートをハニカム状に成形する工程とを含むハニカム状エレクトレットフィルターの製造方法をも提供するものである。

【0010】以下、本発明のハニカム状エレクトレットフィルター（以下、「本発明のフィルター」という）およびその製造方法について詳細に説明する。

[0005] In order to solve this kind of problem, filter which becomes by forming in honeycomb, aforementioned electret-converted nonwoven fabric, (Such as Japan Examined Patent Publication Sho 59-51323 number) has been proposed.

[0006]

[Problems to be Solved by the Invention] But, result these inventors examining. Regarding this kind of honeycomb electret filter, as for being satisfied which of 3 points of (1) low pressure loss, (2) high trapping performance, (3) long period lifetime without being possible was ascertained. In case of filter for example, air conditioner, it is required that pressure loss below mmAq, trapping performance 12% or higher, lifetime of trapping performance for cigarette particle is above the 100.

[0007] Then, objective of this invention, the honeycomb electret filter for air conditioner where to have this kind of low loss of pressure, it was superior in the trapping performance, and lifetime of trapping performance which covers long period, and it is to offer method which can produce its honeycomb electret filter.

[0008]

[Means to Solve the Problems] In order to solve aforementioned problem, as for this invention, being a honeycomb electret filter which the nonwoven fabric laminated sheet which electret formation is done forming in honeycomb, It is something which offers honeycomb electret filter which aforementioned nonwoven fabric laminated sheet, is a laminated sheet which it possesses, electret-converted nonwoven fabric which consists of film split fiber yarn (A), electret-converted nonwoven fabric which consists of melt blowing method nonwoven fabric (B),

[0009] In addition, as for this invention, as method in order to produce the aforementioned honeycomb electret filter, It is something which offers manufacturing method of honeycomb electret filter which is included step which electret formation doing thermoplastic resin film, after forming electret formation film, fiber splitting doing said electret formation film, forms electret-converted nonwoven fabric (A), step which electret formation doing melt blowing method nonwoven fabric which consists of thermoplastic resin, forms electret-converted nonwoven fabric (B), step which laminate doing aforementioned electret-converted nonwoven fabric (A) and electret-converted nonwoven fabric (B), forms laminated sheet, step which said laminated sheet forms in honeycomb.

[0010] You explain in detail below, concerning honeycomb electret filter of this invention (Below, "filter of this invention") and its manufacturing method.

【0011】本発明のフィルターは、フィルム解織糸からなるエレクトレット化不織布（A）と、メルトブローニング法不織布からなるエレクトレット化（B）とを有する積層シートをハニカム状に成形してなるものである。この不織布（A）および（B）は、熱可塑性樹脂からなるものである。用いられる熱可塑性樹脂は、特に制限されず、各種の熱可塑性樹脂を用いることができる。特に、エレクトレット化が容易で、その電荷および捕集性能の持続性が優れている点で、極性基を有するポリオレフィン系重合体または該ポリオレフィン系重合体を含むポリオレフィン組成物が好ましい。この極性基を有するポリオレフィン系重合体またはポリオレフィン組成物として、

(A) 極性基を有する単量体と、 α -オレフィンとの共重合体、

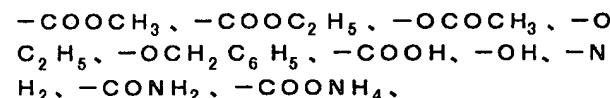
(B) 酸化またはハロゲン化により、ポリオレフィンの側鎖または主鎖に極性基を導入してなる変性ポリオレフィン

(C) ポリオレフィンまたは前記（B）の重合体に、極性基を有する単量体をグラフト共重合してなる変性ポリオレフィン

(D) 未変性ポリオレフィンと、前記（A）、（B）および（C）から選ばれる少なくとも1種との混合物

等の重合体単独、またはその混合物などを主要成分として含む組成物が挙げられる。ここで、ポリオレフィン組成物が、変性ポリオレフィンと未変性ポリオレフィンとを含む場合、変性ポリオレフィンと未変性ポリオレフィンとは、相互に同一のポリオレフィンからなるものであってもよいし、異なるポリオレフィンからなるものであってもよい。

【0012】このポリオレフィン系重合体または該ポリオレフィン系重合体を含むポリオレフィン組成物が有する極性基としては、例えば、塩素原子、フッ素原子、臭素原子、ヨウ素等のハロゲン原子；カルボニル基、ニトロ基等の原子団；あるいは、下記式：



【0013】

[0011] As for filter of this invention, it is something which becomes by forming in honeycomb, laminated sheet which it possesses electret-converted nonwoven fabric which consists of film split fiber yarn (A), electret formation which consists of melt blowing method nonwoven fabric (B). This nonwoven fabric (A) and (B) is something which consists of thermoplastic resin. Thermoplastic resin which is used is not restricted, especially it is possible to use various thermoplastic resin. Especially, electret formation being easy, in point where retention of electric charge and trapping performance is superior, polyolefin type polymer which possesses polar group, or polyolefin composition which includes said polyolefin type polymer is desirable. As polyolefin type polymer or polyolefin composition which possesses this polar group,

(A) Copolymer of monomer which possess polar group and olefin,

(B) the modified polyolefin which becomes due to oxidation or halogenation, introducing polar group into side chain or main chain of polyolefin,

(C) modified polyolefin which becomes by graft copolymerization doing the monomer which possesses polar group, in polymer of polyolefin or aforementioned (B),

(D) Blend of unmodified polyolefin and at least 1 kind which is chosen from the aforementioned (A), (B) and (C).

You can list composition which includes mixture etc of polymer alone or above as main component. When here, polyolefin composition, it includes with modified polyolefin and unmodified polyolefin, modified polyolefin and unmodified polyolefin, it is possible to be something which consists of same polyolefin mutually. It is possible to be something which consists of polyolefin which differs.

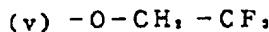
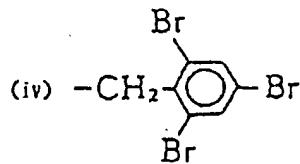
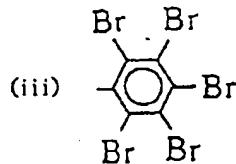
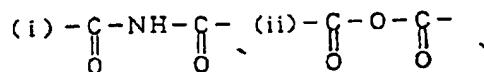
[0012] As polar group which this polyolefin type polymer, or polyolefin composition which includes said polyolefin type polymer has, for example, chlorine atom, fluorine atom, bromine atom, iodine or other halogen atom; carbonyl group, nitro group or other atom group; or, below Formula:



[0013]

【化1】

[Chemical Formula 1]



【0014】で表される基などが挙げられる。これらの極性基の1種または2種以上が、前記ポリオレフィン系重合体またはポリオレフィン組成物に含まれていてもよい。以下、このポリオレフィン系重合体または該ポリオレフィン系重合体を含むポリオレフィン組成物を総称して「ポリオレフィン系組成物」という。

【0015】また、前記(A)極性基を有する単量体と、 α -オレフィンとの共重合体の具体例として、式(iii)で表される基を有するペンタブロモフェニルメタクリレート、または式(iv)で表される基を有する2, 4, 6-トリブロモフェニルメタクリレート、あるいは式(v)で表される基を有するトリフルオロエチルメタクリレート等と、エチレン、プロピレン等の α -オレフィンとの共重合体などが挙げられる。

【0016】また、(B)酸化またはハロゲン化によりポリオレフィンの側鎖または主鎖に極性基を導入してなる変性ポリオレフィンの具体例として、ポリエチレン、ポリプロピレン等を、オゾン、一酸化窒素等と反応させて酸化する、あるいはコロナ放電処理により表面を酸化する等の処理により、分子内にカルボニル基やニトロ基を形成してなるもの、またはポリオレフィンを塩素化して分子内に塩素原子を導入してなるものなどが挙げられる。

【0017】さらに、(C)極性基を有する単量体をグラフト共重合させてなる変性ポリオレフィンの具体例として、不飽和カルボン酸またはその誘導体から選ばれる少なくとも1種の変性単量体で変性された変性ポリオレフィンが挙げられる。

【0018】前記変性ポリオレフィン、または未変性ポリオレフィンの主成分であるポリオレフィンは、 α -オレフィンの単独重合体、2種以上の α -オレフィンからなる共重合体、またはこれらから選ばれる2種以上の混合物である。 α -

[0014] So you can list group etc which is displayed. 1 kind or 2 kinds or more of these polar group, may be included by the aforementioned polyolefin type polymer or polyolefin composition. Below, this polyolefin type polymer , or polyolefin composition which includes said polyolefin type polymer, naming, "polyolefin type composition " with you say.

[0015] In addition, as concrete example of copolymer of monomer which possess aforementioned (A) polar group and -olefin, You can list penta bromophenyl methacrylate which possesses group which is displayed with Formula (iii), Or 2,4,6-tribromophenyl methacrylate which possesses group which is displayed with thetype (iv), Or trifluoro ethyl methacrylate etc which possesses group which is displayed with thetype (v), copolymer etc of ethylene , propylene or other -olefin.

[0016] In addition, as concrete example of modified polyolefin which becomes by introducing polar group into side chain or main chain of polyolefin due to the (B) oxidation or halogenation, polyethylene , polypropylene etc, reacting with ozone , nitrogen monoxide, etc oxidation it does, or surface oxidation is done with corona discharge treatment by or other treatment , those which become by forming carbonyl group and nitro group in intramolecular, or those which become by chlorination doing polyolefin, introducing chlorine atom into intramolecular, can list etc.

[0017] Furthermore, as concrete example of modified polyolef in which becomes by graft copolymerization doing monomer which possesses (C) polar group, You can list modified polyolefin which modification is done with modification monomer of heat least 1 kind which is chosen from unsaturated carboxylic acid or derivative.

[0018] Aforementioned modified polyolefin , or polyolefin wh ich is a main component of unmodified polyolefin, it is a homopolymer of -olefin, copolymer which consists of -olefin of 2 kinds or more, or blend of 2 kinds or more which is

オレフィンとしては、例えば、エチレン、プロピレン、1-ブテン、1-ペンテン、1-ヘキセン、イソペンテン、4-メチル-1-ペンテン、3-メチル-1-ペシテン、1-オクテン、1-デセン、1-ヘキサデセン、1-オクタデセン、1-エイコセン等が挙げられる。

[0019] このポリオレフィンの具体例として、ポリエチレン、ポリプロピレン、ポリ-1-ブテン、ポリ-4-メチル-1-ペンテン、エチレン・プロピレン共重合体、エチレン・1-ブテン共重合体、エチレン・4-メチル-1-ペンテン共重合体、プロピレン・1-ブテン共重合体、4-メチル-1-ペンテン・1-デセン共重合体等が挙げられる。これらの中でも、強度が高く、適度な溶融粘度に調整するのが容易であり、メルトブロー法による成形が容易である点で、ポリプロピレン、ポリ-1-ブテン、ポリ-4-メチル-1-ペンテンが好ましく、特にポリプロピレンが安価で成形し易く、エレクトレット化が容易であるため、特に好ましい。

[0020] また、このポリオレフィンは、適度な流动特性を示すため、メルトブロー法による不織布の製造が容易であり、強度に優れた不織布が得られる点で、[η]が、通常、0.5～3 dL/g、好ましくは0.7～1.5 dL/g、特に好ましくは0.8～1.3 dL/gの範囲のものが好ましい。本発明において、[η]は135°Cデカリン中で測定される値である。

[0021] (C) 変性ポリオレフィンは、前記ポリオレフィンに、不飽和カルボン酸およびその誘導体から選ばれる少なくとも1種の変性単量体をグラフト共重合して変性してなるものである。この変性ポリオレフィンは、未変性ポリオレフィンと同一ないしは相溶性の優れたポリオレフィンを用いることが好ましい。例えば、ポリオレフィン系組成物の成分として、変性ポリオレフィンと未変性ポリオレフィンを含む組成物を使用する場合、未変性ポリオレフィンとしてポリプロピレンを用いるときには、グラフト変性ポリオレフィンの原料ポリオレフィンとして、ポリプロピレンを用いることが好ましい。

[0022] (C) 変性ポリオレフィンをグラフト変性するための変性単量体として用いられる不飽和カルボン酸またはその誘導体として、例えば、不飽和カルボン酸、その無水物、エステル、アミド、イミド、クロリドなどを挙げることができる。

[0023] 前記不飽和カルボン酸またはその誘導体の具体例としては、アクリル酸、メタクリル酸、ビニル酢酸、エチルアクリル酸、2,4-ペンタジエン酸、カルボキシシテレン、マレイン酸、フマル酸、イタコン酸、シトラコン酸、アリルコハク酸、メサコン酸、グルタコン酸、ナジック酸、メチルナジック酸、テトラヒドロフタル酸、アクリル酸メチル、アクリル酸エチル、アクリル酸ブチル、メタクリル酸メ

chosen from these. As -olefin, you can list for example, ethylene, propylene, 1-butene, 1-pentene, 1-hexene, iso pentene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-octene, 1-decene, 1-hexadecene, 1-octadecene, 1-eicosene etc.

[0019] As concrete example of this polyolefin, you can list polyethylene, polypropylene, poly-1-butene, poly-4-methyl-1-pentene, ethylenepropylene copolymer, ethylene-1-butene copolymer, ethylene-4-methyl-1-pentene copolymer, propylene-1-butene copolymer, 4-methyl-1-pentene-1-decene copolymer etc. It is easy, strength to be high even among these, to adjust the moderate melt viscosity. In point where formation with melt blowing method is easy, polypropylene, poly-1-butene, poly-4-methyl-1-pentene desirable. Especially polypropylene being inexpensive, it is easy to form, because the electret formation is easy, especially it is desirable.

[0020] In addition, as for this polyolefin, in order to show moderate flow property, production of nonwoven fabric with melt blowing method is easy. In point where nonwoven fabric which is superior in strength is acquired, [η], usually, those of range of 0.5 to 3 dL/g, preferably 0.7 to 1.5 dL/g, particularly preferably 0.8 to 1.3 dL/g is desirable. In this invention, [η] is value which is measured in 135 °C decalin.

[0021] (C) Modified polyolefin, in aforementioned polyolefin, is something which becomes by graft copolymerization doing modification monomer of at least 1 kind which is chosen from unsaturated carboxylic acid and derivative, modification doing. As for this modified polyolefin, same as unmodified polyolefin, or it is desirable to use polyolefin where compatibility is superior. As component of for example, polyolefin type composition, when composition which includes modified polyolefin and unmodified polyolefin is used, When using polypropylene as unmodified polyolefin, it is desirable to use polypropylene, as starting material polyolefin of grafted polyolefin.

[0022] As unsaturated carboxylic acid or derivative which is used as degeneration monomer in order grafted to do (C) the modified polyolefin, anhydride, ester, amide, imide, chloride etc of for example, unsaturated carboxylic acid, can be listed.

[0023] As aforementioned unsaturated carboxylic acid or concrete example of derivative, listing the acrylic acid, methacrylic acid, vinyl acetic acid, ethyl acrylate, acetic acid, 2,4-pentadienoic acid, carboxy styrene, maleic acid, fumaric acid, itaconic acid, citraconic acid, allyl succinic acid, mesaconic acid, glutaconic acid, Nadic acid, methyl Nadic acid, tetrahydrophthalic acid, methyl acrylate, ethyl acrylate,

チル、メタクリル酸エチル、メタクリル酸ブチル、マレイン酸モノメチル、マレイン酸ジメチル、マレイン酸モノエチル、マレイン酸ジエチル、フマル酸モノメチル、フマル酸ジメチル、フマル酸モノエチル、フマル酸ジエチル、シトラコン酸モノメチル、シトラコン酸ジメチル、シトラコン酸モノエチル、シトラコン酸ジエチル、ナジック酸モノメチル、ナジック酸ジメチル、ナジック酸モノエチル、ナジック酸ジエチル、アクリル酸グリシル、メタクリル酸グリシル、無水マレイン酸、無水イタコン酸、無水シトラコン酸、メチルヘキサヒドロフタル酸、3, 6-エンドメチレン無水フタル酸、無水メチルテトラヒドロフタル酸、アクリルアミド、メタクリルアミド、マレイン酸モノアミド、マレイン酸ジアミド、マレイン酸-N-モノエチルアミド、マレイン酸-N, N-ジエチルアミド、マレイン酸-N-モノブチルアミド、マレイン酸-N, N-ジエチルアミド、フマル酸モノアミド、フマル酸ジアミド、フマル酸-N-モノエチルアミド、フマル酸-N, N-ジエチルアミド、フマル酸-N-モノブチルアミド、フマル酸-N, N-ジブチルアミド、マレイミド、N-ブチルマレイミド、N-フェニルマレイミド、アクリル酸ナトリウム、メタクリル酸ナトリウム、アクリル酸カリウム、メタクリル酸カリウム等が挙げられ、これらは1種あるいは2種以上組み合わせて併用することもできる。これらの中では無水マレイン酸が好ましい。

【0024】上記変性単量体をポリオレフィンにグラフト共重合させて（C）変性ポリオレフィンを調製する方法としては、公知の種々の方法を採用することができる。例えば、ポリオレフィンと変性単量体とを、溶媒の存在下または不存在下に、ラジカル重合開始剤を添加して、または添加せずに高温に加熱して反応させる方法によって行うことができる。また、この反応に際して、ステレン等の他のビニルモノマーを共存させてもよい。

【0025】（C）変性ポリオレフィンにおける変性単量体の含有量、すなわち（C）変性ポリオレフィンのグラフト率は、通常、3モル%以下であり、特に1.5モル%以下の範囲になるように調製することが好ましい。特にポリオレフィン系組成物として変性ポリオレフィン単独を使用して不織布（A）および／または不織布（B）を形成する場合は、グラフト率が1モル%以下であるのが好ましい。

【0026】また、（C）変性ポリオレフィンの固有粘度（135°C、デカリソ）は、未変性ポリオレフィンとの均一な混合が容易となり、適度な流動特性を有し、メルトブローニング法不織布の製造が容易となる点で、通常、0.1～3.0 dl/g、好ましくは0.3～2.0 dl/g、特に好ましくは0.5～1.5 dl/gである。

【0027】本発明において、未変性ポリオレフィンと変性ポリオレフィンとを含むポリオレフィン系組成物を前記不織

butyl acrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate, monomethyl maleate, dimethyl maleate, monoethyl maleate, diethyl maleate, monomethyl fumarate, dimethyl fumarate, monoethyl fumarate, diethyl fumarate, monomethyl citraconate, dimethyl citraconate, monoethyl citraconate, diethyl citraconate, monomethyl Nadate, dimethyl Nadate, monoethyl Nadate, diethyl Nadate, glycidyl acrylate, glycidyl methacrylate, maleic anhydride, itaconic acid anhydride, citraconic acid anhydride, methyl hexahydrophthalic acid, 3,6 -endo methylene phthalic anhydride, methyl tetrahydrophthalic acid anhydride, acrylamide, methacrylamide, maleic acid mono amide, maleic acid di amide, maleic acid -N- mono ethyl amide, maleic acid -N,N -di ethyl amide, maleic acid -N- mono butyl amide, maleic acid -N,N -di ethyl amide, fumaric acid mono amide, fumaric acid di amide, fumaric acid -N- mono ethyl amide, fumaric acid -N,N -di ethyl amide, fumaric acid -N- mono butyl amide, fumaric acid -N,N -di butyl amide, maleimide, N- butyl maleimide, N- phenyl maleimide, sodium acrylate, sodium methacrylate, potassium acrylate, potassium methacrylate etc. These can also jointly use 1 kind or 2 kinds or more combining. Among these maleic anhydride is desirable.

[0024] Graft copolymerization doing above-mentioned modification monomer in polyolefin, as method which manufactures (C) modified polyolefin, various methods of public knowledge can be adopted. for example, it is possible to do with the method which polyolefin and modification monomer, adding radical polymerization initiator under existing of solvent or under absence, or not adding, heating to high temperature, reacts. In addition, styrene or other other vinyl monomer it is possible to coexist at the time of this reaction.

[0025] Content of modification monomer in (C) modified polyolefin, Namely as for grafting ratio of (C) modified polyolefin, Usually, it is a 3 mole % or less. Especially in order to become range of 1.5 mole % or less, it is desirable to manufacture. Especially, using modified polyolefin alone as polyolefin type composition, when nonwoven fabric (A) and/or nonwoven fabric (B) is formed, it is desirable for grafting ratio to be 1 mole % or less.

[0026] In addition, as for intrinsic viscosity (135 °C, decalin) of (C) modified polyolefin, uniform mixing of the unmodified polyolefin becomes easy. It possesses moderate flow property, in point where production of the melt blowing method nonwoven fabric becomes easy, usually, it is a 0.1 to 3.0 dl/g, preferably 0.3 to 2.0 dl/g, particularly preferably 0.5 to 1.5 dl/g

[0027] In this invention, when polyolefin type composition which includes unmodified polyolefin and modified polyolefin it

布（A）および不織布（B）の主材として用いる場合、そのポリオレフィン系組成物における変性ポリオレフィン／未変性ポリオレフィンの含有割合は、通常、重量比で0.1／9.9～20／80程度であり、好ましくは1／99～5／95程度である。

【0028】また、ポリオレフィン系組成物には、前記変性ポリオレフィンおよび未変性ポリオレフィン以外に、本発明の目的を損なわない範囲で、各種の添加剤を配合してもよい。この添加剤としては、例えば、酸化防止剤、紫外線吸収剤、顔料、染料、核剤、充填剤、スリップ剤、アンチブロッキング剤、滑剤、難燃剤、可塑剤等が挙げられる。

【0029】さらに、ポリオレフィン系組成物の調製は、各種の常用の方法にしたがって行なうことができる。例えば、前記変性ポリオレフィンおよび／または未変性ポリオレフィン、ならびに必要に応じて各種の添加剤を混合した後、溶融混練する方法にしたがって行なうことができる。用いられる混合機としては、例えば、リボンブレンダー、V型ブレンダー、タンブラー、ヘンシェルミキサー等があげられる。また、溶融混練は、例えば、一軸または二軸押出機、バンパリーミキサー、ニーダー、二本ロール等を用いて行なうことができる。

【0030】本発明のフィルターを構成する積層シートは、前記ポリオレフィン系組成物を代表例とする熱可塑性樹脂からなる不織布（A）および不織布（B）を有し、不織布（A）はフィルム解纖糸からなるものであり、不織布（B）はメルトブローン法不織布からなるものであり、両層を構成する不織布は、エレクトレット化されてなるものである。不織布（A）と不織布（B）とは、同一の成分からなる熱可塑性樹脂で形成されていてもよいし、異なる成分からなる熱可塑性樹脂で形成されていてもよい。

【0031】前記不織布（A）は、フィルム解纖糸からなるものであり、熱可塑性樹脂フィルムを解纖して製造されるものであれば、その製造方法は特に制限されない。例えば、前記ポリオレフィン系組成物を代表例とする熱可塑性樹脂を押出機で溶融し、環状ダイから押出してフィルムを成形する。このフィルムをスリッターで一定幅に切断し、もしくは切断せずにフィルムをその伸び率以上に延伸することにより解纖して解纖糸を製造する。次に、この解纖糸を、例えば、カーディング等の装置でシートの幅方向に均一に分散させ、次いで好ましくはエンボスロール等で圧着することにより製造することができる。

uses as the primary material of aforementioned nonwoven fabric (A) and nonwoven fabric (B), content of modified polyolefin / unmodified polyolefin in polyolefin type composition, usually, is 0.1/99.9 to 20/80 extent with the weight ratio. It is a preferably 1/99 to 5/95 extent.

[0028] In addition, other than aforementioned modified polyolefin and unmodified polyolefin, in range which does not impair objective of this invention, it is possible to polyolefin type composition, to combine various additive. As this additive, you can list for example, antioxidant, ultraviolet absorber, pigment, dye, nucleating agent, filler, slip agent, antiblocking agent, lubricant, fire retardant, plasticizer etc.

[0029] Furthermore, can manufacture polyolefin type composition, following to various usual method, to do. for example, aforementioned modified polyolefin and/or unmodified polyolefin, after mixing various additive, according to need, Following to method which melt mixing is done, it is possible to do. You can list for example, ribbon blender, V type blender, tumbler, Henschel mixer etc as mixer which is used. In addition, to do making use of for example, single screw or twin screw extruder, Banbury mixer, kneader, dual roll etc it is possible melt mixing.

[0030] As for laminated sheet which forms filter of this invention, nonwoven fabric (A) and nonwoven fabric (B) which consists of thermoplastic resin which designates the aforementioned polyolefin type composition as representative example possessing, nonwoven fabric (A) is something which consists of film split fiber yarn. nonwoven fabric (B) is something which consists of melt blowing method nonwoven fabric. nonwoven fabric which forms both layers, is something which becomes by electret formation being done. nonwoven fabric (A) and nonwoven fabric (B) may be formed with thermoplastic resin which consists of the same component. It is possible to be formed with thermoplastic resin which consists of component which differs.

[0031] Aforementioned nonwoven fabric (A) is something which consists of film split fiber yarn. fiber splitting doing thermoplastic resin film, if it is something which is produced, the manufacturing method especially is not restricted. thermoplastic resin which designates for example, aforementioned polyolefin type composition as the representative example is melted with extruder. extrusion doing from circular die, film it forms. This film with slitter is cut off in constant width, or without cutting off, fiber splitting doing film by drawing doing above elongation, it produces split fiber yarn. Next, with for example, carding or other equipment in transverse direction of sheet dispersion doing this split fiber yarn, in uniform. Next, it can produce by with such as preferably embossing roll pressure bonding doing.

【0032】この不織布（A）は、単纖維の平均纖維径が20～60μmであって、かつ目付量10～30g/m²、嵩密度0.05～0.2g/cm³、および平均表面電荷密度0.1×10⁻⁹クーロン/cm²以上であるエレクトレット化不織布である。ここで、本発明において、単纖維の平均纖維径は、纖維試料表面の電子顕微鏡写真（500倍）を撮影し、得られた写真上で30本の纖維を任意に選び、各纖維の纖維径をノギス等を用いて測定し、各纖維径の測定値の平均値を計算して求められる値である。

【0033】また、不織布（A）のエレクトレット化処理は、フィルム成形時に行ってもよいし、不織布を成形後に該不織布をエレクトレット化する方法によって行ってもよい。ここで、フィルム成形時に行なう場合は、エレクトレット化の効率に優れるため、捕集性能が、成形後の不織布をエレクトレット化する場合と比べて良好となり好ましい。

【0034】エレクトレット化は、不織布またはフィルムに直流電圧を印加して行なうことができる。印加される直流電圧値は、使用する電極の形状、電極間距離等、また、エレクトレット化不織布に要求される帶電電荷量、処理速度等に従って適宜選択される。例えば、電極間距離が8mmの場合、少なくとも-5kV、好ましくは-6～-20kVの直流電圧を不織布に印加して行なうことができる。

【0035】直流電圧の印加は、いずれの方法に従って行ってもよく、特に制限されない。例えば、不織布またはフィルムを直流電圧を印加した一対の電極間に通して行なう方法；不織布の表面にコロナ放電やパルス状高電圧を加える方法；不織布の表裏両面を他の誘電体で保持し、両面に直流高電圧を加える方法などいずれの方法によって行ってもよい。

【0036】さらに、不織布（B）を構成するメルトブローング法不織布は、まず、熱可塑性樹脂、好ましくは前記したポリオレフィン系組成物を押出機等に供給して加熱溶融、混練し、多数の細孔を有するメルトブロー用ダイから微細な樹脂流として押出す。押し出された樹脂流を高速の加熱気体流と接触させて冷却、固化させて、微細な纖維径の不連続纖維に形成し、この纖維を多孔性支持体上に累積させることにより製造することができる。

[0032] As for this nonwoven fabric (A), it is a electret-converted nonwoven fabric which average fiber diameter of single fiber being 20 to 60 μm, at same time, is above apparent weight 10 to 30 g/m², bulk density 0.05 to 0.2 g/cm³, and average surface charge density 0.1×10⁻⁹ C/cm². Here, electron microscope photograph (500 time) of fiber sample surface photography it does average fiber diameter of the single fiber, in this invention, it chooses fiber of 30 optionally on photograph which is acquired. fiber diameter of each fiber is measured making use of calipers etc. Calculating mean value of measured value of each fiber diameter, it is a value which is sought.

[0033] In addition, it is possible to do electret-forming process of nonwoven fabric (A), at the time of film molding. After forming it is possible to do nonwoven fabric with method which the said nonwoven fabric electret formation is done. When here, it does at time of film molding, because it is superior inefficiency of electret formation, trapping performance, becomes satisfactory in comparison with case where the electret formation it does nonwoven fabric after forming, is desirable.

[0034] Imprinting doing direct current voltage in nonwoven fabric or film, to do it is possible the electret formation. as for direct current voltage which imprinting is done, electrode shape, electrode spacing etc which is used, In addition, following to charging amount of electric charge, process rate etc which is required to the electret-converted nonwoven fabric, it is selected appropriately. When for example, electrode spacing is 8 mm, imprinting doing direct current voltage of -5 kV, preferably -6 to -20 kV atleast in nonwoven fabric, it is possible to do.

[0035] Following to any method, it is possible to do imprinting of direct current voltage, especially is not restricted. for example, method which nonwoven fabric or film passing between pair of electrodes which through direct current voltage imprinting is done it does; method which adds corona discharge, pulse high voltage to surface of nonwoven fabric; method etc which keeps both front and back sides of nonwoven fabric with other dielectric, adds direct current high voltage to both surfaces, It is possible to do with any method.

[0036] Furthermore, melt blowing method nonwoven fabric which forms nonwoven fabric (B) first, thermoplastic resin, preferably polyolefin type composition which before was inscribed, supplying to extruder etc, heating and melting, kneading, extrusion it does as microscopic resin stream from die for melt blowing which possesses multiple pore. Contacting with heated gas stream of high speed to cool resin stream which was pushed out, solidification doing forms in discontinuous fiber of microscopic fiber diameter, can produce by

【0037】ポリオレフィン系組成物の溶融、混練における加熱温度は、ポリオレフィン系組成物の主成分であるポリオレフィンの融点によって適宜調整される。ポリオレフィンが減成して低分子量化せず、良好な機械的強度を有する不織布が得られ、また、溶融されたポリオレフィン系組成物の溶融粘度が適度で溶融成形が容易となる点で、通常、200～350°C程度、特に、220～300°Cの範囲で行うことが好ましい。

【0038】ポリオレフィン系組成物の溶融混練および押出の吐出量は、通常、10～130 kg/h程度である。

【0039】また、用いられるメルトブロー用ダイは、溶融されたポリオレフィン系組成物を吐出する細孔を先端リップ部に、多数有するものであり、通常、幅1000～2000 mmのものである。この細孔は、先端リップ部に、通常、800～3000個設されており、その孔径は、通常、0.5 mm程度である。

【0040】また、メルトブロー用ダイにおいて、溶融ポリオレフィン系組成物は、高速度の加熱気体と接触し、分割されると共に、溶融状態でドラフトされて纖維長方向へ引き延ばされると共に、さらに纖維径の微細化が進行する。そのため、メルトブロー用ダイは、高速の加熱気体流を導入し、ダイの内部またはダイの外部で、溶融されたポリオレフィン系組成物と加熱気体流とを接触させて微細な不連続単纖維に成形する装置を有する。この装置は、メルトブロー用ダイの内部に加熱気体流の吹出口を配設してなるものでもよいし、メルトブロー用ダイの先端リップ外側に溶融されたポリオレフィン組成物に加熱気体流を吹き付けるように加熱気体流の吹出口を配設してなるものでもよい。

【0041】加熱気体は、特に制限されず、コストの点で加熱空気が一般に使用されるが、ポリオレフィン系組成物の劣化を防止するために加熱された不活性気体を使用してもよい。加熱気体流の温度は、通常、200～360°C、特に好ましくは230～310°Cで、溶融されたポリオレフィン組成物の温度より少なくとも10°C程度は高いことが好ましい。また、加熱気体流の流速は、通常、100～600 m/sec、特に200～400 m/sec程度であることが望ましい。

【0042】メルトブロー用ダイから吐出される微細な不連続単纖維を、多孔性支持体上に集積させてウェーブ状のメルトブローニ法不織布を得ることができる。この多孔性支持体

accumulating this fiber on porous support.

[0037] As for heating temperature in melting and kneading of polyolefin type composition, It is adjusted appropriately by melting point of polyolefin which is a main component of polyolefin type composition. polyolefin forming, decrease molecular weight reduction it does not do, nonwoven fabric which possesses satisfactory mechanical strength is acquired. In addition, melt viscosity of polyolefin type composition which is melted being moderate, point where melt molding becomes easy. Usually, 200 to 350 °C extent, especially, it is desirable to do in range of the 220 to 300 °C.

[0038] Melt mixing of polyolefin type composition and extrusion amount of extrusion, usually, are the 10 to 130 kg/h extent.

[0039] In addition, die for melt blowing which is used, is something which the polyolefin type composition which is melted pore which discharges in end lip, the large number it possesses. Usually, it is something of width 1000 to 2000 mm. This pore is installed, in end lip, usually, 800 to 3000. hole diameter, usually, is 0.5 mm extent.

[0040] In addition, in die for melt blowing, as for molten polyolefin composition, it contacts with heated gas of high speed, is divided, draft being done with molten state, as it is prolonged to fiber length direction, furthermore fining of fiber diameter advances. Because of that, die for melt blowing, possesses equipment which introduces heated gas stream of the high speed, polyolefin type composition and heated gas stream which with inside of die or outside of die, is melted contacting, forms in microscopic discontinuous single fiber. This equipment, may be something which becomes by arranging spray outlet of heated gas stream in inside of die for melt blowing, it is possible to be something which becomes by arranging spray outlet of heated gas stream, in order to blow heated gas stream to polyolefin composition which is melted in end lip outside of die for melt blowing .

[0041] Heated gas is not restricted especially, hot air is used generally in the point of cost. It is possible to use inert gas which is heated in order to prevent the deterioration of polyolefin type composition. temperature of heated gas stream usually, with 200 to 360 °C, particularly preferably 230 to 310 °C. it is desirable for 10 °C extent to be at least higher than the temperature of polyolefin composition which is melted. In addition, as for flow rate of heated gas stream, usually, it is desirable to be a 100 to 600 m/sec and especially 200 to 400 m/sec extent.

[0042] Accumulating microscopic discontinuous single fiber which discharges from die for melt blowing on porous support. melt blowing method nonwoven fabric of web can be acquired.

として、例えば、ステンレス、ポリエステル等からなる網目構造体等を用いることができる。

【0043】この不織布（B）は、単纖維の平均纖維は、適度な通気性を有し、微細な粉塵に対する集塵性が良好である点で、通常、 $0.5 \sim 10 \mu\text{m}$ 程度であり、特に好ましくは $1 \sim 6 \mu\text{m}$ の範囲であり、纖維長は、通常、 $50 \sim 400 \text{ mm}$ 程度である。また、嵩密度は $0.05 \sim 0.40 \text{ g/cm}^3$ 程度であり、目付量は、適度な通気性を有し、強度の高い不織布が得られ、また、局部的な目付量のばらつきが少ない点で、通常、 $5 \sim 100 \text{ g/m}^2$ 程度であり、特に $10 \sim 80 \text{ g/m}^2$ の範囲が好ましい。

【0044】さらに、不織布（B）の厚さは、目付量と嵩密度にしたがって決定されるが、通常、 $0.1 \sim 0.7 \text{ mm}$ 程度である。

【0045】この不織布（B）のエレクトレット化は、前記不織布（A）のエレクトレット化と同様の方法で行なうことができる。

【0046】さらにまた不織布（B）の平均表面電荷密度は、エレクトレットとして十分な集塵性能を発揮することができる点で、通常、 0.1×10^{-9} クーロン/ cm^2 以上であり、好ましくは $0.3 \sim 5 \times 10^{-9}$ クーロン/ cm^2 である。

【0047】また、エレクトレット化不織布（B）の構成材である単纖維を形成する熱可塑性樹脂の極限粘度 $[\eta]$ （ 135°C 、デカリン）は、 $0.3 \sim 1.5 \text{ dL/g}$ であり、好ましくは $0.5 \sim 1.0 \text{ dL/g}$ である。

【0048】本発明のフィルターを構成する積層シートは、前記不織布（A）と不織布（B）を有するものである。積層シートの層構成は、不織布（A）／不織布（B）の構成以外にも、不織布（B）／不織布（A）／不織布（B）および不織布（A）／不織布（B）／不織布（A）の構成をとり得るが、不織布（A）／不織布（B）となる積層構造が、本発明の目的を達成できる点で最も好ましい。

【0049】また、積層シートにおける不織布（A）の好ましい厚さは $0.1 \sim 0.5 \text{ mm}$ であり、不織布（B）の好ましい厚さは $0.1 \sim 0.7 \text{ mm}$ であり、積層不織布シート全体の好ましい厚さは $0.2 \sim 1 \text{ mm}$ である。

【0050】積層シートの製造は、前記不織布（A）および不織布（B）を、それぞれロール状に巻いておき、そのロー

As this porous support, it is possible to use mesh structure etc which consists of the for example, stainless steel, polyester etc.

[0043] As for this nonwoven fabric (B), as for average fiber of single fiber, moderate air permeability possessing. In point where dust collecting property for microscopic powder dust is satisfactory, usually, it is a 0.5 to $10 \mu\text{m}$ extent, is a range of particularly preferably 1 to $6 \mu\text{m}$. fiber length, usually, is 50 to 400 mm extent. In addition, bulk density is 0.05 to 0.40 g/cm^3 extent, apparent weight has moderate air permeability, the nonwoven fabric where strength is high is acquired. In addition, in point where scatter of local apparent weight is little, usually, it is a 5 to 100 g/m^2 extent. Range of especially 10 to 80 g/m^2 is desirable.

[0044] Furthermore, thickness of nonwoven fabric (B) is decided, following to the apparent weight and bulk density,, but usually, it is a $0.1/0.7 \text{ mm}$ extent.

[0045] As for electret formation of this nonwoven fabric (B), it is possible to do with method which is similar to electret formation of the aforementioned nonwoven fabric (A).

[0046] Furthermore average surface charge density of nonwoven fabric (B), in point which can show the sufficient dust collecting performance as electret, usually, is above $0.1 \times 10^{-9} \text{ C/cm}^2$. It is a preferably 0.3 to $5 \times 10^{-9} \text{ C/cm}^2$.

[0047] In addition, as for limiting viscosity [] (135°C , decalin) of thermoplastic resin which forms single fiber which is a constituent material of electret-converted nonwoven fabric (B), It is a 0.3 to 1.5 dL/g is a preferably 0.5 to 1.0 dL/g .

[0048] Laminated sheet which forms filter of this invention aforementioned nonwoven fabric (A) with is something which possesses nonwoven fabric (B). layer configuration of laminated sheet, can take constitution of nonwoven fabric (B)/nonwoven fabric (A) / nonwoven fabric (B) and nonwoven fabric (A) / nonwoven fabric (B) / nonwoven fabric (A) in addition to constituting nonwoven fabric (A) / nonwoven fabric (B). laminated structure which becomes nonwoven fabric (A) / nonwoven fabric (B) , is most desirable in point which can achieve objective of this invention.

[0049] In addition, thickness where nonwoven fabric (A) in laminated sheet is desirable is the 0.1 to 0.5 mm thickness where nonwoven fabric (B) is desirable is 0.1 to 0.7 mm thickness where laminated nonwoven fabric sheet entirety is desirable is 0.2 to 1 mm

[0050] Production of laminated sheet, winds aforementioned nonwoven fabric (A) and nonwoven fabric (B), respectively in roll.

ルからそれぞれ不織布を同一速度で繰り出して、積層一体化する装置に供給して積層し、得られる積層シートを巻き取る方法を採用することができる。また、不織布(A)を成形するときに、不織布(B)を同時に成形装置に導入して両者を積層する方法も採用することができる。

【0051】2つの不織布を積層一体化するための装置としては、例えば、熱ロール、超音波融着等を挙げることができる。熱ロール法では両不織布シートを110℃～140℃に加熱したエンボスロールにより積層化処理を行うことが好ましい。また、超音波融着においては、周波数10～50kHz、ホーン圧力2～4kg/cm²の条件で積層することが好ましい。これらの積層方法のうちでは成形体の剛性が高いためハニカム成形性が良好な積層シートが得られる点で、電荷の消失が少ない熱エンボス融着法がより好ましい。

【0052】本発明のフィルターは、前記積層シートをハニカム状に成形してなるものである。この積層シートをハニカム状に成形する方法としては、特に制限されず、例えば、前記積層シートを一定幅にスリット後、連続的に折り畳み、または折り曲げ、不織布シートの全面にひだを形成して厚さを持たせるとともに多数の連続空隙、すなわちハニカム状セルを有する構造を形成する方法が挙げられる。積層シート同士の接触の接着は、接着剤や積層シート同士を融着させることにより相互に固着させることが好ましい。

【0053】このハニカム状セルの製造方法として、例えば、図1(a)に示すように、不織布(A)と不織布(B)とを有する積層シート1を連続的に折り曲げ、多数の山部2と谷部3を連続して有する第1シート4を作製する。この第1シート4を、不織布(A)と不織布(B)とを有する積層シートからなる平坦な第2シート5に重ね合わせ、谷部3の底部6を第2シート5の表面に接着して、図1(b)に示すように、構成単位7を作製する。次に、このような構成単位7を所要枚数作製した後、図1(c)に示すように、第1の構成単位7₁と第2の構成単位7₂を積層し、第1の構成単位7₁の山部2の頂部8を第2の構成単位7₂の下表面に接着し、さらに、同様に第2の構成単位7₂の上に第3の構成単位7₃を積層して、第2の構成単位7₂の山部の頂部を第3の構成単位7₃の下表面に接着する。この積層および接着工程を繰り返して、あるいは第1シート4と第2シートを積層した一対の組合せを多数形成し、その一対の組合せを所要枚数重ねて、多数のハニカム状セル9を有する構造体を形成する方法を挙げることができる。

From roll drawing out respective nonwoven fabric with same velocity. Supplying to equipment which laminated layer integration is done, laminated layer it does, method which retracts laminated sheet which is acquired can be adopted. In addition, when nonwoven fabric (A) forming, introducing nonwoven fabric (B) into the molding equipment in simultaneous, laminated layer is done also method which can adopt both.

[0051] for example , hot roll , ultrasonic melt bonding etc can be listed as equipment in order laminate integration to do the2 nonwoven fabric. It is desirable to do lamination, with hot roll method with embossing roll whichheats both nonwoven sheets to 110 °C to 140 °C. In addition, laminate it is desirable with condition of frequency 10 to 50 KHz , horn pressure 2 to 4 kg/cm²regarding ultrasonic melt bonding, to do. Among these laminate method, because stiffness of molded article is high, honeycomb moldability in point where satisfactory laminated sheet is acquired, thermal embossing melt bonding method whose disappearance of electric charge is little is moredesirable.

[0052] Filter of this invention, is something which becomes by aforementioned laminated sheet forming in honeycomb . Especially it is not restricted this laminated sheet as method which forms inthe honeycomb. for example , aforementioned laminated sheet in constant width after slit,folding, or are bent in continuous. Forming pleat in entire surface of nonwoven sheet, it can give thickness. You can list method which forms structure which possesses multiple continuous space , namely honeycomb cell. As for glueing of contact of laminated sheet, it is desirable to adheremutually by melt adhesion doing adhesive and laminated sheet.

[0053] As manufacturing method of this honeycomb cell, as shown in for example , Figure 1 (a), laminated sheet 1 which possesses nonwoven fabric (A) and nonwoven fabric (B) is bent to continuous, it produces 1st sheet 4 which it possesses continuing multiple ridge 2and valley 3 . This 1st sheet 4, is superposed to flat 2nd sheet 5 which consists of laminated sheetwhich possesses nonwoven fabric (A) and nonwoven fabric (B). Glueing bottom part 6 of valley 3 to surface of 2nd sheet 5, as shown inthe Figure 1 (b), it produces constituting unit 7. As next, necessary number of layers after producing this kind of constituting unit 7, shownin Figure 1 (c), first constitution unit 71 and second constitution unit 72 laminated layer are done. It glues head 8 of ridge 2 of first constitution unit 71 , to bottom surface of the second constitution unit 72 . Furthermore, on constituting unit 72 of 2nd, laminated layer doing constituting unit 73 ofthe 3rd in same way. It glues head of ridge of constituting unit 72 of 2nd, to thebottom surface of constituting unit 73 of 3rd. This laminated layer and bonding step over again. Or combination of pair which 1st sheet 4 and

2nd sheet laminated layer is done large number is formed. Necessary number of layers repeating combination of pair, you can list method which forms structure which possesses multiple honeycomb cell 9.

【0054】本発明のフィルターは、ハニカムの厚さが5～20 mm、ハニカムの単位セルの形状は図1に示すようなものであり、通常、セルの高さが1～5 mm、セルの底辺が2～10 mmのものである。

【0055】

【実施例】次に、実施例を挙げて本発明をさらに具体的に説明するが、本発明はその要旨を越えない限りこれらの実施例になんら制約されるものではない。

【0056】(実施例1) 密度0.91 g/cm³、かつMFRが800 g/10分(ASTM D 1238)であるポリプロピレン(A)97重量部と、無水マレイン酸変性ポリプロピレン(B)(無水マレイン酸のグラフト量:2.7重量%、固有粘度:0.3 dl/g)3重量部とを、タングラーブレンダーで混合してポリオレフィン組成物(組成物I)を調製した。この組成物I中の無水マレイン酸の含有量は、3.9×10⁻²モル%であった。

【0057】次に、この組成物Iをスクリュー径65 mmφの単軸押出機に投入し、310°Cで溶融させ、押出機の先端に接続されたメルトブロー用ダイから20 kg/hrの吐出量で押出すとともに引き取り速度13 m/minで引き取り、メルトブローン法不織布を成形した。使用したメルトブロー用ダイは、ダイ幅:1.3 mでダイ全幅にわたって2列の成形孔(孔径:0.5 mmφ、孔間隔:0.8 mm)が開口されているものである。また、この成形において、メルトブロー用ダイには、320°Cの加熱空気を500 m³/hrの流量で注入した。

【0058】得られたメルトブローン法不織布の厚さは0.49 mm、目付量は30 g/m²、嵩密度は0.067 g/cm³であった。また、メルトブローン法不織布を構成する繊維を顕微鏡で観察して平均繊維径を測定したところ、4 μmであった。さらに、この繊維を形成する樹脂の[η]は0.58 dl/gであった。

【0059】次に、このメルトブローン法不織布を、針状電極を長さ方向に5 mm間隔で2列に配列して構成してなる電荷印加装置に、-18 kVの直流電圧を印加しながら、20 m/minの速度で連続的に通過させて、エレクトレット化メルトブローン法不織布を製造した。

[0054] As for filter of this invention, thickness of honeycomb 5 to 20 mm. shape of unit cell of honeycomb, is kind of something which is shown in Figure 1. Usually, height of cell base of 1 to 5 mm, cell is something of the 2 to 10 mm

[0055]

[Working Example(s)] Next, listing Working Example, further more you explain this invention concretely, but if this invention does not exceed gist, it is not something which is restricted in these Working Example.

[0056] (Working Example 1) Polypropylene (A) 97 parts by weight which is a density 0.91 g/cm³, and MFR 800 g/10 min (ASTM D 1238), maleic anhydride-modified polypropylene (B) (graft amount: 2.7 weight %, intrinsic viscosity: 0.3 dl/g of maleic anhydride) 3 parts by weight, mixing with tumbler blender, polyolefin composition (composition I) was manufactured. content of maleic anhydride in this composition I was 3.9x10⁻² mole%.

[0057] Next, to throw this composition I to single screw extruder of screw diameter 65 mm diameter, melting with the 310 °C. From die for melt blowing which is connected to end of the extruder, extrusion it does with extrusion amount of 20 kg/h takeup, with take-up speed 13 m/min, melt blowing method nonwoven fabric it formed. As for die for melt blowing which you use, molding hole (hole diameter: 0.5 mm diameter, hole spacing: 0.8 mm) in the 2 line is opened with die width: 1.3 m over die entire width. In addition, hot air of 320 °C injection was done to die for melt blowing, with flow of 500 m³/hr at time of this forming.

[0058] As for thickness of melt blowing method nonwoven fabric which it acquires 0.49 mm. As for apparent weight as for 30 g/m², bulk density it was a 0.067 g/cm³. In addition, observing fiber which forms melt blowing method nonwoven fabric with microscope, when it measured average fiber diameter, it was a 4 μm. Furthermore, [η] of resin which forms this fiber was 0.58 dl/g.

[0059] Next, this melt blowing method nonwoven fabric, in longitudinal direction arranging needle electrode into 2 line with 5 mm interval, in charging equipment which becomes by constituting, while imprinting doing direct current voltage of -18 kV, with velocity of the 20 m/min passing in continuous, electret formation melt blowing method nonwoven fabric was

【0060】得られたエレクトレット化メルトブローン法不織布の平均表面電荷密度を測定したところ、 1.2×10^{-9} クーロン/ cm^2 であった。なお、この平均表面電荷密度の測定は、理化学研究所製の表面電荷密度測定装置を用い、面積 1 cm^2 の電極プローブを不織布表面に接触させて行なった。

【0061】ポリプロピレン（三井石油化学工業株式会社製、ハイポールB200、MFR: 0.5 g/10分) 9000g、ポリカーボネート（ゼネラルエレクトリック社製、レキサン101) 500g および無水マレイン酸変性ポリプロピレン（無水マレイン酸グラフト変性量：3重量%）500g を混合して樹脂組成物を調製した。

【0062】得られた樹脂組成物を、インフレーションフィルム成形機（東芝機械（株）製）に供給して、 240°C で、厚さ $30 \mu\text{m}$ のフィルムに成形した。次に、このフィルムを、 135°C に加熱された熱板にて長手方向に6.6倍の延伸倍率で延伸して延伸フィルムを得た。次に、延伸フィルムを、印加電圧-9kV（直流）、電極間隔：8mmのコロナ放電極に滞留時間0.5秒で供給して荷電処理を施した後、針山状ロールに掛けて、網目状に解織し、得られたエレクトレット化解織糸を紙管に巻き取った。このエレクトレット化解織糸をカッターで90mmに切断し、開綿機により開綿してエレクトレット化原綿を得た。

【0063】次に、このエレクトレット化原綿をウェップ・フォーミング・マシンに供給して、ウェップに成形した。

【0064】このウェップと前記エレクトレット化メルトブローン法不織布とを、 130°C に設定した熱エンボスロールに供給してボンディングにより貼り合わせて、目付量： 25 g/m^2 、厚さ0.32mmのエレクトレット化不織布の積層シートを得た。

【0065】次に、この積層シートを図1(a)～(c)に示す工程にしたがって、30段のハニカム状シートからなり、底辺4.2mm、高さ2.7mmのハニカムセルを70個有するハニカム状エレクトレットフィルターを製造した。このハニカム状エレクトレットフィルターを切断し、縦70mm、横297mm、厚さ5mmの試験用フィルターを作成した。

【0066】この試験用フィルターの捕集効率を、下記の方

produced.

[0060] When average surface charge density of electret formed on melt blowing method nonwoven fabric which it acquires was measured, it was 1.2×10^{-9} C/cm 2 . Furthermore, measurement of this average surface charge density Institute for Physical and Chemical Research (RIKEN) make used the surface charge density measuring apparatus. Contacting nonwoven fabric surface, it did electrode probe of surface area 1 cm 2 .

[0061] Mixing polypropylene (Mitsui Petrochemical Industries, Ltd. make, Hipol B200 and MFR: 0.5 g/10 min) 9000g, polycarbonate (General Electric Co. make and Lexan 101) 500g and maleic anhydride-modified polypropylene (amount of grafted maleic anhydride: 3 wt%) 500g, it manufactured resin composition.

[0062] Supplying resin composition which it acquires, to inflation on film molding machine (Toshiba Machine Ltd. make). With 240°C , it formed in film of thickness 30 m. Next, with hot plate which is heated to 135°C , in machine direction the drawing doing this film, with draw ratio of 6.6-fold. drawn film was acquired. Next, applied voltage -9 kV (direct current), corona discharge of electrode interval: 8 mm extremely supplying the drawn film, with residence time 0.5 second. After administering charging, applying on sharp peak shape roll, fiber splitting it does in mesh. electret formation split fiber yarn which is acquired was retracted in paper tube. This electret formation split fiber yarn with cutter is cut off in 90 mm. Opening cotton doing with cotton opener, it acquired the electret formation raw cotton.

[0063] Next, supplying this electret formation starting fiber to web-forming machine, it formed in web.

[0064] Supplying to thermal embossing roll which sets this web and aforementioned electret formation melt blowing method nonwoven fabric, to the 130°C . With bonding pasting together, laminated sheet of electret-converted nonwoven fabric of apparent weight: 25 g/m^2 , thickness 0.32 mm was acquired.

[0065] Next, following to step which shows this laminated sheet in Figure 1 (a) to (c), it consists of honeycomb sheet of 30-stage honeycomb electret filter which 70 it possesses honeycomb cell of base 4.2 mm, height 2.7 mm was produced. This honeycomb electret filter is cut off. Vertical 70 mm, filter for test of side 297 mm, thickness 5 mm was drawn up.

[0066] Following trapping efficiency of filter for this test, to be

法にしたがって測定した。測定結果は、各時間とも5個の測定値の平均値で表示した。結果を表1に示す。

【0067】捕集効率の測定

図2に概略を示す装置を用いて捕集効率を測定した。まず、エアロゾル発生機（日本科学工業社製）11からNaCl粒子（粒径：0.3 μm）をエアーフィルター12を通じて清浄な空気を導入したチャンバー13内に供給した。該チャンバー13内のNaClの濃度が一定（ $2 \sim 6 \times 10^6$ 個/cm³）になった後、吸引装置14により、チャンバー13の底部に配置したフィルター試料15を介して矢印Aの方向に吸引し、フィルター通過風速が一定速度（v = 10 cm/sec）となった時のフィルター試料25の上流16および下流17側におけるNaCl粒子濃度CinおよびCoutをそれぞれパーティクルカウンター（リオン社製、KC-01B）18a、18bによって測定し、下記式によって捕集効率を求めた。19は流速計、20は流量調節バルブである。

$$\text{捕集効率 } E = (1 - C_{\text{out}} / C_{\text{in}}) \times 100 \quad [\%]$$

【0068】圧力損失の測定

差圧計（山武ハネウエル社製、KD146）を用い、捕集効率の測定と同時に行った。

【0069】フィルター寿命の測定

図3に示すとおり、内容積1 m³のアクリル樹脂製の箱21の内部に市販のエアコン（松下電気産業（株）製、エオリア）22および攪拌ファン23を設置した装置を用意した。次に、試験フィルターをエアコン内にセットし、箱21内に煙草を燃焼させて発生する煙を注入した後、箱21内の煙濃度の減衰を、粉塵計（柴田科学（株）製、P-5）を用いて測定した。最初に、フィルターをエアコンにセットしない状態で、箱21内にタバコ1本を燃焼させたときに発生する煙を注入した後、エアコン22を作動させ初期濃度の1/2となる半減期を求め、ブランク値とする。煙草を所定本数燃焼させ、発生した煙をフィルターに捕集させて、その箱内の粉塵量の半減時間がブランク値と初期値の差の1/2まで到達したときの煙草の積算燃焼本数をフィルターの寿命とする。

【0070】（実施例2）実施例1の組成物Iにおいて、ポリプロピレン（A）／（無水マレイン酸グラフト変性ポリプロピレン（B））の配合比を95/5に変更する以外は、実

low-mentioned method, it measured. Also each time 5 it indicated measurement result, with mean value of the measured value. Result is shown in Table 1.

[0067] Measurement of trapping efficiency

Trapping efficiency was measured making use of equipment which shows outline in Figure 2. First, it supplied inside chamber 13 which introduces clean air the NaCl particle (particle diameter: 0.3 μm), via air filter 12 from aerosol generator (Nihon Kagaku Kogyo Co., Ltd. supplied) 11. After concentration of NaCl inside said chamber 13 becomes fixed (2 to 6×10^6 /cm³), with suction equipment 14, through filter sample 15 which is arranged in bottom of the chamber 13, it absorbs in direction of arrow A. When filter-penetrating air speed becoming constant rate (v=10 cm/sec), NaCl particle concentration Cin and Cout in upstream 16 and downstream 17 side of filter sample 25 is measured due to the respective particle counter (Rion supplied, KC-01B) 18a, 18b. trapping efficiency was sought with below Formula. As for 19 as for flowmeter, 20 it is a flow-regulating valve.

$$\text{Trapping efficiency } E = (1 - C_{\text{out}} / C_{\text{in}}) \times 100 \quad [\%]$$

[0068] Measurement of loss of pressure

Making use of differential pressure gauge (Yamatake Honeywell supplied, KD146), it did in measurement simultaneous of the trapping efficiency.

[0069] Measurement of filter lifetime

As shown in Figure 3, in inside of box 21 of acrylic resin of the internal volume 1 m³, equipment which installs commercial air conditioner (Matsushita Electrical Industrial Co., Ltd. make, Eolia) 22 and agitating fan 23 was prepared. Next, test filter is set inside air conditioner, injection after doing smoke which burning, generates cigarette inside box 21. It measured attenuation of smoke concentration inside box 21, making use of the powder dust meter (Shibata science Ltd. make and P-5). First, with state which does not set filter to air conditioner, injection after doing smoke which when burning, generates the tobacco 1 inside box 21. air conditioner 22 operating, it seeks half-life which becomes 1/2 of the initial stage concentration, makes blank value, cigarette specified number burning, collecting smoke which occurs in the filter. When, half-life of amount of powder and dust inside box arriving to 1/2 of difference of blank value and initial value, integrated number burned of cigarette is designated as the lifetime of filter.

[0070] (Working Example 2) In composition I of Working Example 1, other than modifying the mix ratio of polypropylene (A) / (maleic anhydride grafted polypropylene (B)) in 95/5,

施例1と同様にしてエレクトレット化不織布を製造し、さらに、フィルターを作成した。フィルターの作成に用いた組成物中の無水マレイン酸の含有量は、 6.5×10^{-2} モル%であった。得られたフィルターの嵩密度は 0.065 g/cm^3 、平均表面電荷密度は 1.4×10^{-9} クーロン/ cm^2 、繊維を形成する樹脂の $[\eta]$ は 0.57 dL/g 、平均繊維径は $4 \mu\text{m}$ であった。また、フィルターの初期性能、ならびにタバコ寿命を測定した。結果を表1に示す。

[0071] (実施例3) 実施例1の方法により得られたフィルターの代わりに、超音波処理（処理条件；ホーン圧力： 2.6 kg/cm^2 、周波数： 20 kHz 、処理速度： 25 m/min ）によりエレクトレット化不織布（A）とエレクトレット化不織布（B）とを積層することによって得られた積層不織布シートを用いる以外は実施例1と同様に行って、フィルターを作製し、そのフィルターの初期性能、および煙草寿命を測定した。結果を表1に示す。

[0072] (比較例1) 実施例1のフィルターの代わりに、解繊糸より得られたエレクトレット化不織布のみを用いる以外は、実施例1と同様にしてハニカム状エレクトレットフィルターを製造した。得られたフィルターの嵩密度は 0.092 g/cm^3 、目付けは 25 g/cm^2 であった。また、フィルターの初期性能、ならびにタバコ寿命を測定した。結果を表1に示す。

[0073] (比較例2) 実施例1のエレクトレットフィルターの代わりに、メルトプローン法により得られたエレクトレット化不織布（B）のみを用いる以外は、実施例1と同様にしてハニカム状エレクトレットフィルターを製造した。得られたフィルターの嵩密度は 0.067 g/cm^3 、目付量は 25 g/cm^2 、平均表面電荷密度は 1.3×10^{-9} クーロン/ cm^2 であった。また、フィルターの初期性能、ならびにタバコ寿命を測定した。結果を表1に示す。

electret-converted nonwoven fabric is produced to similar to Working Example 1. Furthermore, filter was drawn up. content of maleic anhydride in composition which is used for compilation of filter was 6.5×10^{-2} mole%. as for bulk density of filter which is acquired 0.065 g/cm^3 . As for average surface charge density $1.4 \times 10^{-9} \text{ C/cm}^2$. As for [] of resin which forms fiber 0.57 dL/g , average fiber diameter was $4 \mu\text{m}$. In addition, initial stage performance of filter, and tobacco lifetime were measured. Result is shown in Table 1.

[0071] (Working Example 3) In place of filter which is acquired with method of Working Example 1, Other than using laminated nonwoven fabric sheet which is acquired with ultrasonic treatment (processing condition ; horn pressure : 2.6 kg/cm^2 , frequency : 20 kHz , process rate : 25 m/min) by laminate doing electret-converted nonwoven fabric (A) and electret-converted nonwoven fabric (B), doing in same way as Working Example 1, it produces filter. initial stage performance of filter, and cigarette lifetime were measured. Result is shown in Table 1.

[0072] (Comparative Example 1) In place of filter of Working Example 1, other than using only electret-converted nonwoven fabric which is acquired from split fiber yarn, honeycomb electret filter was produced to similar to Working Example 1. as for bulk density of filter which is acquired 0.092 g/cm^3 . basis weight was 25 g/cm^2 . In addition, initial stage performance of filter, and tobacco lifetime were measured. Result is shown in Table 1.

[0073] (Comparative Example 2) In place of electret filter of Working Example 1, other than using only electret-converted nonwoven fabric (B)which is acquired with melt blowing method, honeycomb electret filter was produced to similar to Working Example 1. as for bulk density of filter which is acquired 0.067 g/cm^3 . As for apparent weight as for 25 g/cm^2 , average surface charge density it was a $1.3 \times 10^{-9} \text{ C/cm}^2$. In addition, initial stage performance of filter, and tobacco lifetime was measured. Result is shown in Table 1.

[0074]

[0074]

表1 フィルター性能

	ΔP (mmHg)	E (%)	寿命 (本)
実施例 1	0. 5	13. 2	50
2	0. 5	14. 1	50
3	0. 7	12. 2	60
比較例 1	0. 5	14. 3	6
2	1. 1	8. 8	80

[0075]

【発明の効果】本発明のハニカム状エレクトレットフィルターは、前記不織布（A）と不織布（B）の2層以上からなり、従来のメルトブローン法不織布のみからなるハニカム状エレクトレットフィルターに比べて圧力損失が低く、かつ捕集性能が優れている。また、従来の解織糸からなる不織布で構成されるフィルターに比べると捕集性能の長期寿命が優れている。

【0076】そのため、本発明のハニカム状エレクトレットフィルターは、上記の特長を生かしてエアコン、空気清浄機、掃除機、ファンヒーター、一般空調機器用、自動車室内用等のエアフィルターとして好適に使用することができる。

【0077】また、本発明のハニカム状エレクトレットフィルターは、エアーフィルターとして用いた場合、初期の捕集性能が高いだけでなく、その捕集性能が持続し、フィルターの寿命が長いため、有用である。

【図面の簡単な説明】

【図1】 本発明のハニカム状エレクトレットフィルターの製造方法の主要工程を説明する図。

【図2】 本発明の実施例および比較例において行なった捕集効率の測定方法を説明する概略図。

[0075]

[Effects of the Invention] Honeycomb electret filter of this invention consists of 2 layers or more of aforementioned nonwoven fabric (A) and nonwoven fabric (B). In comparison with honeycomb electret filter which consists of only conventional melt blowing method nonwoven fabric, pressure loss is low, at same time trapping performance is superior. In addition, when you compare to filter which is formed with the nonwoven fabric which consists of conventional split fiber yarn, long period lifetime of trapping performance is superior.

[0076] Because of that, as for honeycomb electret filter of this invention, utilizing the above-mentioned feature, can use for ideal as air conditioner, air cleaning machine, vacuum cleaner, fan heater and/or other air filter for general air conditioner, automobile interior.

[0077] In addition, as for honeycomb electret filter of this invention, when it uses as air filter, trapping performance of initial stage not only high, trapping performance continues. Because lifetime of filter is long, it is useful.

[Brief Explanation of the Drawing(s)]

【Figure 1】 Figure which explains principal step of manufacturing method of the honeycomb electret filter of this invention.

【Figure 2】 Conceptual diagram which explains measurement method of trapping efficiency which was done in the Working Example and Comparative Example of this invention.

【図3】 本発明の実施例および比較例において行なったフィルター寿命の測定方法を説明する概略図。

【符号の説明】

- 1 積層シート
- 2 山部
- 3 谷部
- 4 第1シート
- 5 第2シート
- 6 谷部3の底部
- 7 構成単位
- 8 山部2の頂部
- 9 ハニカム状セル
- 11 エアロゾル発生機
- 12 エアーフィルター
- 13 チャンバー
- 14 吸引装置
- 15 フィルター試料
- 16 フィルター試料15の上流
- 17 フィルター試料15の下流
- 18 a, 18 b パーティクルカウンター
- 19 流速計
- 20 流量調節バルブ
- 21 箱
- 22 エアコン
- 23 搅拌ファン

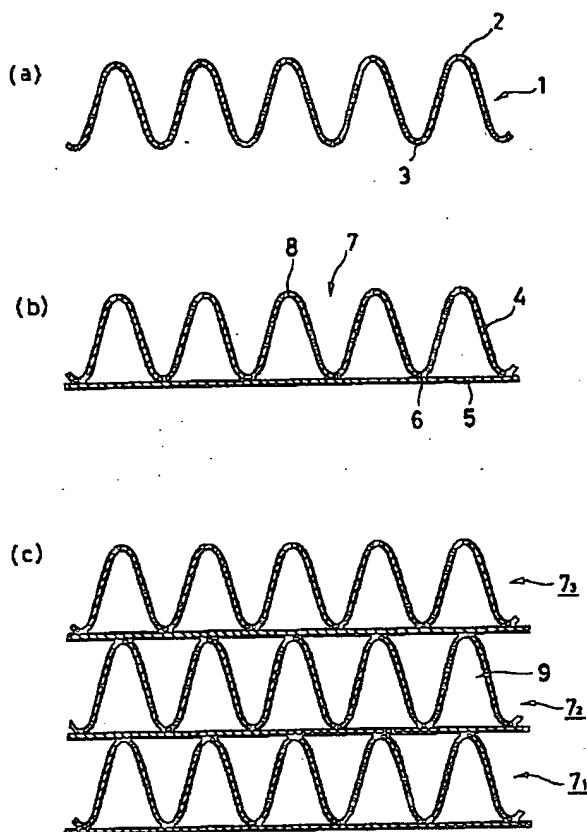
[Figure 3] Conceptual diagram which explains measurement method of filter lifetime which was done in the Working Example and Comparative Example of this invention.

[Explanation of Reference Signs in Drawings]

- 1 laminated sheet
- 2 ridge
- 3 valley
- 4 1st sheet
- 5 2nd sheet
- 6 . bottom of valley 3
- 7 constituting unit
- 8 . top of ridge 2
- 9 honeycomb cell
- 11 aerosol generator
- 12 air filter
- 13 chamber
- 14 suction equipment
- 15 filter sample
- 16 . upstream of filter sample 15
- 17 . downstream of filter sample 15
- 18a,18b particle counter
- 19 flowmeter
- 20 flow-regulating valve
- 21 box
- 22 air conditioner
- 23 agitating fan

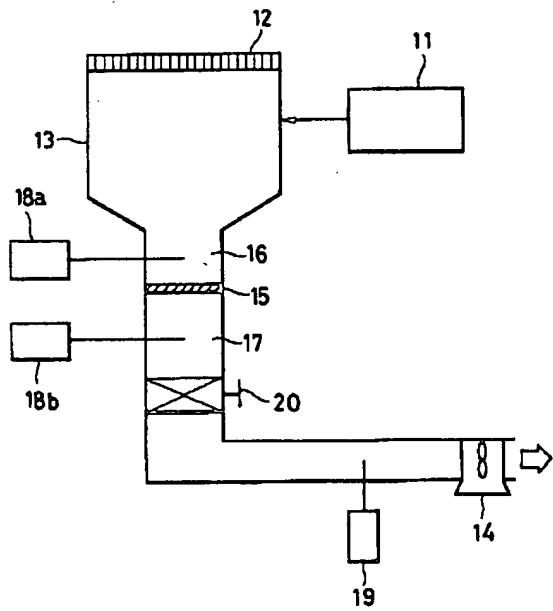
【図1】

[Figure 1]



【図2】

[Figure 2]



【図3】

[Figure 3]

